FARMERS' BULLETIN 1069
UNITED STATES DEPARTMENT OF AGRICULTURE

TUBERCULOSIS IN LIVE STOCK

Detection, Control, and Eradication

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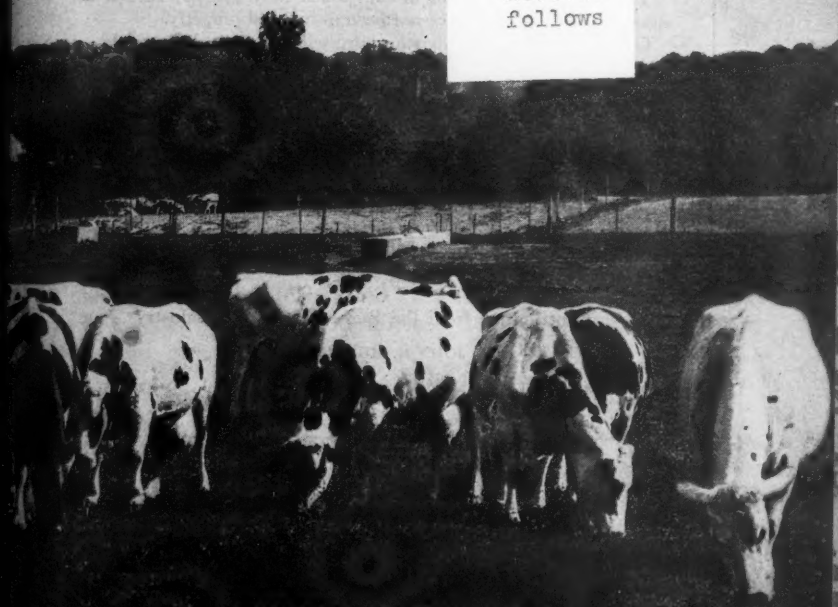

THE FIRST HERD IN THE UNITED STATES OFFICIALLY ACCREDITED AS FREE FROM TUBERCULOSIS.

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HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE.

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

By the addition of an animal that is affected with the disease; therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

By feeding calves with milk or other dairy products from tuberculous cows; this frequently occurs where the owner purchases mixed skim milk from the creamery, and feeds it to his calves without first making it safe by boiling or pasteurization.

By showing cattle at fairs and exhibitions; reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

The shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

Community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

Contribution from the Bureau of Animal Industry

JOHN R. MOHLER, Chief

Washington, D. C. November, 1919

TUBERCULOSIS IN LIVE STOCK.

DETECTION, CONTROL, AND ERADICATION.

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PRESENT KNOWLEDGE OF TUBERCULOSIS.

PROBABLY no disease affecting either the human race or live stock is better known or has been the object of so much study as tuberculosis. Present knowledge of the disease is derived from many sources, including the work of eminent scientists who discovered its cause, and studies of the numerous ways in which it is spread, of the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1882 by the eminent scientist, Dr. Robert Koch. Thus the test has been known for more than a third of a century. The facts regarding it and other information presented in this bulletin are based upon long experience and results verified many times. The methods recommended to be used in the eradication of tuberculosis have been tried upon large numbers of herds and found to be effectual and practicable.

EARLY ERADICATION IS MOST ECONOMICAL.

Live-stock owners are earnestly requested not to wait until the States and Federal Government come into their localities to eradicate tuberculosis. It would not be possible indeed, at this stage to undertake to eradicate tuberculosis from the live stock of the United States solely through organized official forces established by the respective States and the Federal Government. The area over which tuberculosis has spread is too vast, the herds too numerous, and

funds are insufficient for conducting the work on so extensive a plan even though trained veterinarians were available in sufficient numbers to do the work. Every live-stock owner should be a party to this campaign which has been inaugurated to eradicate tuberculosis. In almost every locality of the United States are veterinarians capable of rendering valuable services to live-stock owners in this great work, and the cost of eradicating is greatly reduced by combating the disease in its early stages. Yet even in badly affected herds eradication can be undertaken with success. There are records of many herds, in which three-fourths of the animals

FIG. 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. Upon application of the tuberculin test, 37, or 82 per cent, of the animals were found to be tuberculous. The germs of the disease may live for months in manure or litter.

were affected with tuberculosis, which eventually were freed from it and afterwards maintained in a healthy condition.

The extirpation of tuberculosis from live stock is important not only from an economic standpoint, but also because a considerable percentage of tuberculosis in the human family, especially among children, is positively due to the consumption of infected milk or other dairy products from tuberculous cows. It is eminently proper for the respective State governments to expend funds for the maintenance of tuberculosis sanitariums for the care of persons afflicted with that disease, and likewise it is extremely important to use vigorous measures to check the marketing of germ-laden milk. While it is true that proper pasteurization of milk destroys the living organisms

of tuberculosis, a large part of the milk consumed daily is not pasteurized, and some of the milk so treated is not always made entirely safe.

TUBERCULOSIS A DECEPTIVE DISEASE.

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among the live-stock owners, who would insist upon its immediate eradication; but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals, many people believe that it does comparatively little damage among live stock. Contrary to such opinions, however, the loss from tuberculosis is one of the heaviest taxes imposed upon our live-stock industry, amounting, probably, to at least $40,000,000 a year in the United States.

PREVALENCE OF TUBERCULOSIS.

In every State and Territory in the Union there is some tuberculosis among cattle and swine, though the degree varies considerably. In some States it probably exists quite extensively, the percentage varying from 5 to 30 per cent of the cattle population, while in certain others investigations indicate that less than 1 per cent of the total of beef and dairy cattle are tuberculous.

Tuberculosis is known to exist also quite extensively among cattle and swine in all the European countries; in fact, no part of the world is known to be free from it absolutely. There are, however, some restricted regions where its presence is not known, or it exists to but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States, tuberculosis among live stock in those regions was unknown so far as we know. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but live-stock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the live-stock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

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In some localities in the West, where dairying has developed extensively, it is now known that carload lots of cows purchased in other States have contained 50 per cent or more of tuberculous animals. Some herds of beef cattle in our western country have become contaminated with the disease by placing among them tuberculous pure-bred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is to-day. Consequently in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick. Therefore there is probably less tuberculosis among the herds of the Southern States than in any other part of the Nation. This favorable condition should be taken advantage of, for in all probability the live-stock industry will reach a high development in that area in future years. It is especially important that the herds of the Southern States be protected by permitting only tuberculosis-free animals to enter.

FIG. 2.—An insanitary barn. Nearly all the cows kept in it were tuberculous. The stone foundation wall retains about 2 feet of liquid manure which contains millions of tubercle germs. Premises of this character can not be kept sanitary.

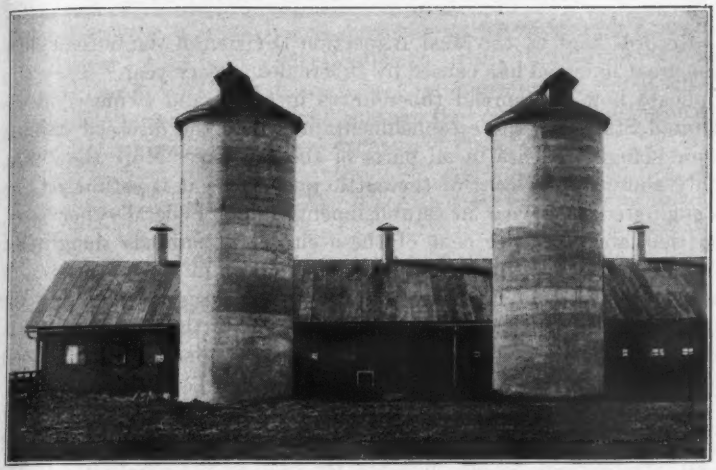

FIG. 3.—A modern sanitary barn. Note ventilators and liberal window space.

HOW THE DISEASE SPREADS IN A HERD.

The tuberculous cow is the greatest source of danger to healthy cattle. Any reacting cattle not promptly removed from the herd constitute a source of constant infection.

Tuberculous cattle, sooner or later, begin to give off the germs of the disease. These germs escape by the mouth, nose, and bowels, in the milk, and other discharges. The discharged germs are carried in the air for a time until they fall to the ground.

Animals in adjoining stalls may take in the germs in the feed they eat and thus contract the disease. Continuous water troughs in barns containing diseased cattle are a source of danger. Drinking holes containing material from infected animals are likewise dangerous.

Failure to clean and disinfect the premises occupied by the diseased cattle constitutes another source of danger. Infected milking tubes and the practice of feeding calves with raw milk from tuberculous cows are other means by which tuberculosis spreads in a herd.

LOSSES OF MEAT FOOD PRODUCTS.

Records kept by the Meat Inspection Division of the bureau show the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 per cent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 per cent of these classes of animals slaughtered each year in the United States do not appear in these records. It is known also that the percentage of tuberculosis is greater in the uninspected animals. In view of these points the losses shown in the following table are believed to be scarcely one-half of the total loss throughout the country.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is placed aside for further examination. If the disease is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed and the remainder is passed. It will be noted that such is the case in most carcasses retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In the animals that are retained and when the disease is not extensive enough to cause condemnation of the entire carcass, the disease is in most cases in the early stages. Had the animals been allowed to live for possibly only a short time longer, the disease would have progressed until all the carcass would have to be considered diseased. In others the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and endanger healthy cattle and swine.

HOW TO PROCEED TO MAKE CERTAIN THAT CATTLE AND SWINE ARE FREE FROM TUBERCULOSIS.

Have a competent veterinarian apply the tuberculin test. Remove all reactors promptly, and disinfect the premises immediately after the removal of the reacting cattle.

Do not feed any infected dairy products to swine or young cattle.

Retest the herd with tuberculin once a year.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger, State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from that farm.

TABLE 1.—*Number of cattle and swine slaughtered, and those retained and condemned on account of tuberculosis at establishments where Federal meat inspection is maintained.*

	Cattle.			Swine.		
Fiscal year.	Slaughtered.	Retained.	Condemned.	Slaughtered.	Retained.	Condemned.
1907[1]	5,867,642	24,876	17,117	26,189,026	362,445	48,544
1908	7,116,275	68,395	24,371	35,113,077	719,279	77,554
1909	7,325,337	100,650	24,525	35,427,931	860,425	45,113
1910	7,962,189	123,501	27,638	27,656,021	792,176	28,880
1911	7,781,030	133,551	27,186	29,916,363	1,117,789	31,517
1912	7,532,005	160,122	35,273	34,966,378	1,643,100	42,267
1913	7,155,816	152,560	33,001	32,287,538	1,809,751	47,632
1914	6,724,117	143,699	29,738	33,289,705	2,201,005	48,252
1915	6,964,402	158,239	32,644	36,247,958	2,774,835	66,023
1916	7,404,288	190,991	37,085	40,482,799	3,687 817	74,109
1917	9,299,489	218,928	46,351	40,210,847	3,970,168	76,867
1918	10,938,287	222,787	40,692	35,449,247	2,494,587	59,740

[1] Covers 9 months from October 1, 1906, to June 30, 1907.

CAUSE OF TUBERCULOSIS.

The direct and primary cause of tuberculosis is a rod-shaped germ which can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or live stock is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures, paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other inclosures which contained tuberculous animals before healthy ones are again placed in them.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose

the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuberculosis among the stock whenever the germs are present. Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED WITH TUBERCULOSIS.

The tuberculous cow is the greatest source of danger to healthy cattle, and inasmuch as it can not be determined just when that animal becomes a "spreader" of the germs, unless daily microscopic tests are made of the discharges from the body, and the milk is also examined microscopicaliy, it is unsafe to keep it with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming into contact with affected animals than in any other

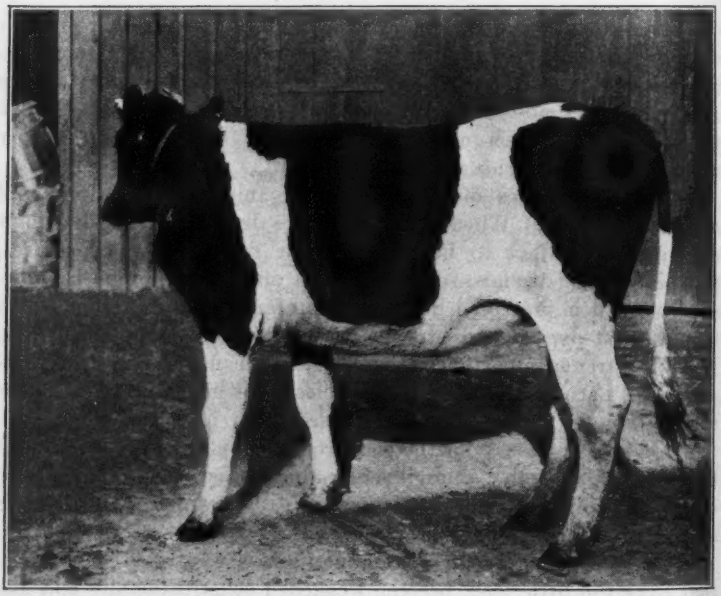

FIG. 4.—A tuberculous heifer. The gland at the shoulder was diseased and discharging tuberculous pus.

way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

The continuous water trough in barns is also accountable to a very large extent for spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which infected milk or the washings from infected milk cans have been dumped may also be a source of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected frequently by drinking milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE MAY BECOME INFECTED.

The tuberculous cow is not only a menace to other cattle but is also the commonest source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the development of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record, also, in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are kept on the same farm, some of the latter are tuberculous. Eradication of tuberculosis from cattle, it is believed, will greatly reduce its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuber-

culosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another.

SYMPTOMS OF TUBERCULOSIS.

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms. Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions

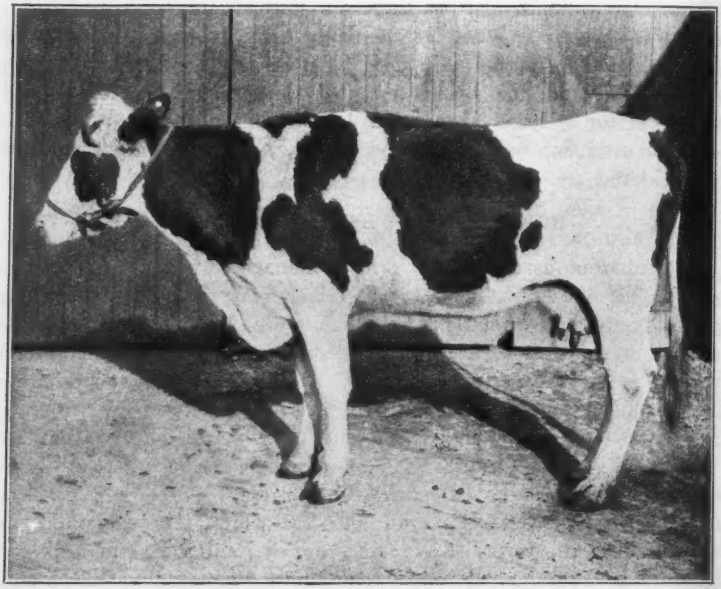

FIG. 5.—A reacting cow that was constantly "bloating." The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating.

which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body, an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands

of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening, as shown in figure 4. Animals affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an animal are affected, it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased, the animal often develops bloat (fig. 5). Diarrhea is often evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

FIG. 6.—Part of a tuberculous udder showing well-developed lesions.

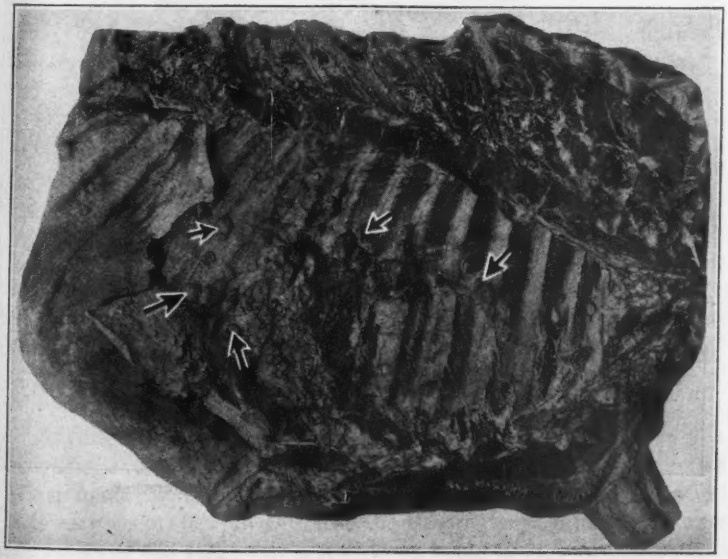

FIG. 7.—Beef carcass showing tuberculous nodules on ribs.

METHODS OF DIAGNOSIS.

Microscopic examinations of sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of experience the tuberculin test is now considered to be the most practicable and satisfactory way of discovering the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

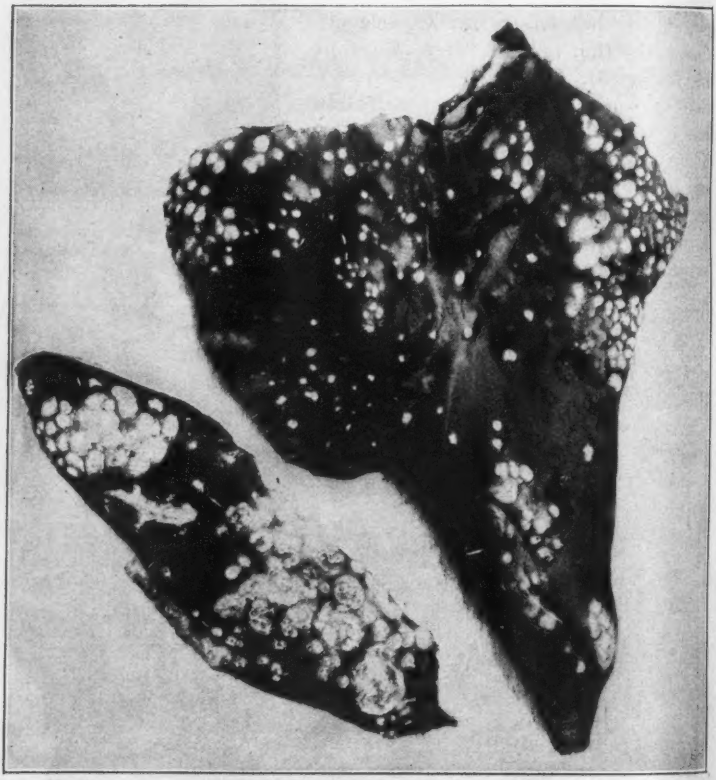

FIG. 8.—Liver and spleen showing extensive lesions of tuberculosis.

THE TUBERCULIN TEST.

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and in the hands of skillful persons, it is a reliable agent for detecting tuberculosis in animals. It contains no living tubercle bacilli but is a product of the growth of tubercle bacilli properly mixed with a substance on which it has grown and properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used.

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action. Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to its application at another time; therefore it may be misused by unscrupulous persons.

THE SUBCUTANEOUS TEST (UNDER THE SKIN).

The most frequently used method of testing is the subcutaneous test, which consists in injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to measure the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are measured at least 3 times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the person applying the test, and a careful observance of any clinical changes is always important in determining the result. It can not be set forth too strongly that the test including the two following methods, should be attempted only by those who are properly qualified to do the work.

THE INTRADERMAL TEST (INTO THE SKIN).

The intradermal test for detecting tuberculosis is used to a considerable extent, especially on range cattle not easily controlled. When made by those who have become skilled in its application, it is very accurate. In this test the tuberculin is injected between the layers of the skin, only a few drops being used, and it is usually

applied in the region at the base of the tail, where the skin is soft and nearly hairless. The intradermal test is satisfactory also for the diagnosis of tuberculosis in swine and, when so used, the tuberculin is applied into the skin of the ear near its base.

The reaction from the intradermal test consists of a swelling at the point of injection and is observed from 48 to 108 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced person.

THE OPHTHALMIC TEST (INTO THE EYE).

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the previously described methods. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the

RELIABILITY OF THE PRINCIPAL TUBERCULIN TESTS.

The subcutaneous test is the principal test used by the U. S. Bureau of Animal Industry. It consists in injecting, under the skin, a small quantity of tuberculin. Carefully and conscientiously applied, with good judgment exercised in both its administration and interpretation, it is wholly effective.

The intradermal test is recognized by the bureau on strictly range cattle or animals whose movements are difficult to control, and in area work. In this test the tuberculin is injected between the layers of the skin.

The ophthalmic test, or so-called "eye test," is not at present accepted for testing cattle for interstate shipment, though it has value as a check test and is recognized for that purpose. It is applied by placing the ophthalmic tuberculin in one eye, using the other as a check. The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit. In all cases the tests, used either alone or in combination, should be applied by capable persons familiar with tuberculin testing.

FIG. 9.—Part of a herd of 69 cattle, 30 per cent tuberculous in 1917, 5 per cent tuberculous in 1918, 100 per cent free from tuberculosis in 1919. The herd is now accredited.

disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from

FIG. 10.—How a herd may become reinfected with tuberculosis. This herd was free from tuberculosis for a number of years. During 1917, 4 cattle were purchased in another State and placed in the herd without proper tuberculin test. When official test was made, December, 1917, 5 reactors were found. Three of the reactors were slaughtered and 2 kept in the herd. At the next test, January, 1919, 11 reactors and 2 suspects were in the herd of 28 cattle.

the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

POST-MORTEM APPEARANCES.

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs. The lesions are of various sizes and may contain pus, either soft or hard; many times it is gritty. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities. Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands, to some extent, are usually affected, and, when cut into, show diseased areas characteristic of tuberculosis.

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible for even the most skillful person in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals reacting to the test were not affected with tuberculosis to some extent even though some were very slight.

METHODS OF ERADICATION.

Cattle owners who do not know whether tuberculosis exists among their animals should ascertain the fact by having them tuberculin-tested and physically examined by a qualified veterinarian. In many cases thousands of dollars and very valuable breeding animals might have been saved by taking up tuberculosis-eradication work in time. Three main projects comprise the general campaign of eradication, as follows:

1. Eradication of tuberculosis from pure-bred herds of cattle.
2. Eradication of tuberculosis from circumscribed areas.
3. Eradication of tuberculosis from swine.

It is important to eradicate tuberculosis from pure-bred herds of cattle at the earliest possible date because the spread of the disease is greater among such animals than among grade cattle. The reason is plain; pure-bred animals are shipped extensively to every part of the United States for breeding purposes. A pure-bred bull or cow may be shipped from Maine to Texas, or from the State of Washington to Florida. If it is diseased and is introduced into a healthy herd, it not only fails to fulfill the purpose for which it was intended—the upbreeding of the herd—but it actually causes heavy damage by spreading the disease to healthy animals.

FIG. 11.—This Hereford herd was freed from tuberculosis within 3 years. The first test, in 1916, showed the herd to be 10 per cent tuberculous. The reactors were removed and in 1918 all the 62 animals in the herd were found to be healthy.

ACCREDITED-HERD OR HONOR-ROLL PLAN.

The breeders of pure-bred registered cattle fully appreciated the above-mentioned fact when, together with the live-stock sanitary officials of practically all the States, they adopted what is known as the accredited-herd plan, the principles of which are that herds found to be free from tuberculosis on two successive annual tests are placed on the Honor Roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of one year. This plan is becoming well known to breeders throughout the United States. The progress of the accredited-herd plan is given in Table 2.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for pure breds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly

tuberculin tested. To make a satisfactory test all the cattle should be in normal condition and, so far as practicable, the cattle should be stabled under usual conditions and among usual surroundings. Feeding and watering should be conducted in the customary manner, with the exception that feed and water should be given only after the temperature has been taken. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

TABLE 2.—*Status of cooperative tuberculosis-eradication work, including all herds under supervision, April 1, 1919.*

State.	Accredited.			Once passed.			One or more reactors.		
	Herds.	Cattle.		Herds.	Cattle.		Herds.	Cattle.	
		Pure-bred.	Grade.		Pure-bred.	Grade.		Pure-bred.	Grade.
Alabama				57	501	830	16	807	310
Arkansas	1	31	44	15	293	73	9	153	51
Colorado							4	76	1
Connecticut	6	83	19	16	135	59	18	460	252
Delaware				3	19	30	4	333	83
District of Columbia	139	130	311	130	7	475	9		130
Florida				192	125	2,722	54	86	1,580
Georgia	5	185	14	36	358	733	76	926	3,084
Idaho				148	161	736	28	5	146
Illinois	6	180	17	55	991	313	93	2,837	706
Indiana	15	303	79	105	1,745	703	42	789	712
Iowa				43	1,048	273	51	1,959	353
Kansas				72	1,292	486	33	1,147	425
Kentucky	5	199	39	129	1,618	1,188	24	710	248
Louisiana				44	484	927	34	578	1,539
Maine	21	198	140	427	1,524	3,672	74	447	1,028
Maryland	21	150	413	116	556	1,268	107	762	2,345
Massachusetts	10	152	79	26	441	90	17	649	156
Michigan	25	604	45	62	1,598	81	65	2,627	29
Minnesota	131	3,428	708	259	4,039	3,179	224	4,814	2,491
Mississippi	2		29	643	869	4,358	35	592	1,302
Missouri				3	98	12	4	97	87
Montana	11	265	83	112	784	999	45	1,168	1,362
Nebraska				32	622	117	34	973	181
Nevada									
New Hampshire				7	195	41	4	59	16
New Jersey	1	49		8	240	93	13	410	963
New York	1	16		65	1,204	788	57	1,248	610
North Carolina	4	30	87	255	579	2,809	64	353	2,129
North Dakota	68	1,374	357	684	3,842	4,770	132	2,213	1,481
Ohio	19	710	31	262	3,484	1,140	136	2,965	1,223
Oklahoma				7	1	73	4	18	65
Oregon	19	422	60	74	1,173	603	19	222	459
Pennsylvania	2	207		228	1,297	1,798	67	868	778
Rhode Island				3	18	25	11	184	45
South Carolina	7	60	182	86	441	1,808	48	342	1,608
South Dakota				224	321	1,043	72	1,010	1,068
Tennessee	10	259	32	218	1,957	2,201	64	1,334	1,464
Utah	14	507	12	810	408	5,855	95	6	408
Vermont	16	329	191	190	1,050	2,532	181	2,623	4,574
Virginia	196	1,231	3,914	486	976	6,789	278	952	7,955
Washington	7	255	24	56	901	570	24	590	424
West Virginia	3	203		27	167	237	11	139	227
Wisconsin	17	522	29	118	1,956	1,047	88	2,198	694
Wyoming				2	10	79			
Total	782	12,082	6,939	6,535	39,558	57,685	2,468	40,729	44,800

FIG. 12.—An accredited Jersey herd, Minnesota.

PRINCIPAL BENEFITS OF COMPLETE ERADICATION OF TUBERCULOSIS.

Increased value of individual animal and increased herd value.

Ability to ship interstate from accredited herds without further testing for a period of one year.

The owner's name being listed in pamphlets published by the respective States and the Bureau of Animal Industry.

Confidence by those who desire to purchase cattle to add to their herds.

Satisfaction of knowing that the dairy products offered for sale are free from diseased germs.

Elimination of economic losses caused by the disease.

ERADICATION FROM AREAS.

The unit territory to be worked will depend mainly upon the extent to which the disease has spread. In some States practically every county contains numerous tuberculous herds, so that, to control the disease effectively, all the herds must be tuberculin tested. In other States, however, the disease is confined to the beef and dairy herds recently established or to which new animals have lately been added. In the latter case it would not be necessary to test all the cattle, but the examination of the herds should be sufficient to demonstrate most satisfactorily that no diseased herds are overlooked. This can be done by testing several herds in each section of the county wherever there is a suspicion that the disease may exist.

As a general plan, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county should pay (1) part of the expense of exterminating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it is advisable to clean up the herds within a township or possibly one-third or one-half of the area. The progress depends upon the degree of infection found and the cooperation furnished by the owners.

FIG. 13.—An accredited Guernsey herd, Wisconsin.

FIG. 14.—An accredited Ayrshire herd, West Virginia.

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin tested; of the total number, 321 cattle, or 18.87 per cent, were tuberculous. The reactors were removed from the herds and, in most instances, were slaughtered. The infected barns, sheds, and premises were cleaned and disinfected. Each year since the inauguration of the campaign all the cattle have been tuberculin tested with the result that the infection has almost disappeared.

There are States in which tuberculosis exists to less than 1 per cent among all the bovine population. The plan of carrying on eradication in several counties at the same time in those States is practicable and is being conducted in a number of States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make, it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The larger herds, especially around cities and those supplying milk locally and for shipment to other cities, should be tested before the small lots. If it is known that the herds are but slightly infected, the intradermal method should be employed, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermal test, the entire herd should be tested subcutaneously within a short time. The ophthalmic test may also be used in conjunction with the subcutaneous in "check" testing

FIG. 15.—An accredited herd of pure bred Milking Shorthorns, Virginia.

herds. General experience shows that it is sound practice, if there is any doubt, to use all three methods of testing with tuberculin. Such a policy is especially applicable to cattle which have been tested frequently, and among herds which are or have been extensively diseased.

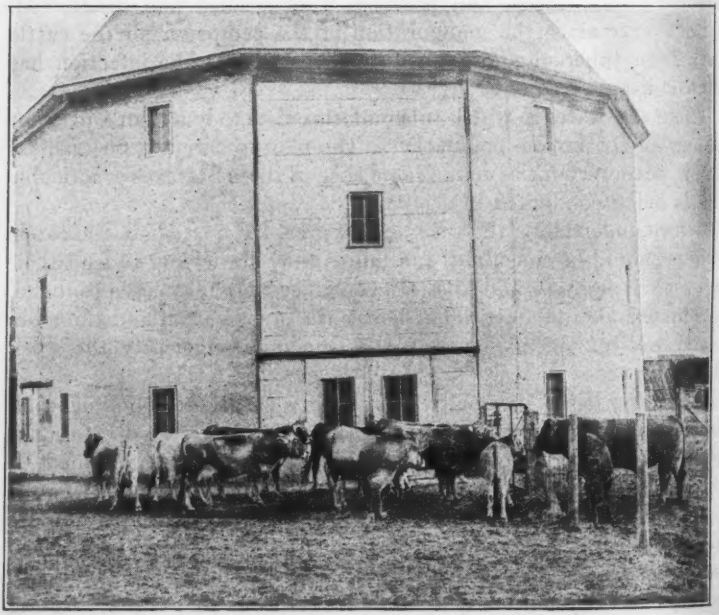

FIG. 16.—An accredited Brown Swiss herd, Indiana.

ERADICATION FROM SWINE.

With the gradual elimination of tuberculosis from cattle, the disease among swine will grow correspondingly smaller. It is not necessary to tuberculin test all the swine herds because, with the exception of valuable breeding animals, it is more economical to slaughter the diseased ones when fat than to undertake to exterminate the disease in any other way.

In the case of suspected, valuable pure-bred swine, their freedom from tuberculosis can be determined definitely by the intradermal method, which is practicable and reliable.

The injection is near the base of the left ear; the other ear acts as a check for comparison. A reaction is manifested by a swelling in the

FIG. 17.—An accredited Red Poll herd, Virginia.

region where the tuberculin was injected. The swelling may appear any time from the 24th to the 104th hour after injection and will remain for several days. As in the case of cattle, diseased swine should be removed from the farm, and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

MEASURES OF PREVENTION.

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regu-

lating the movements of cattle, and recently, with that object in view, action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the live-stock owner. It is he who must take a very important part all through the campaign of tuberculosis eradication, and if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped

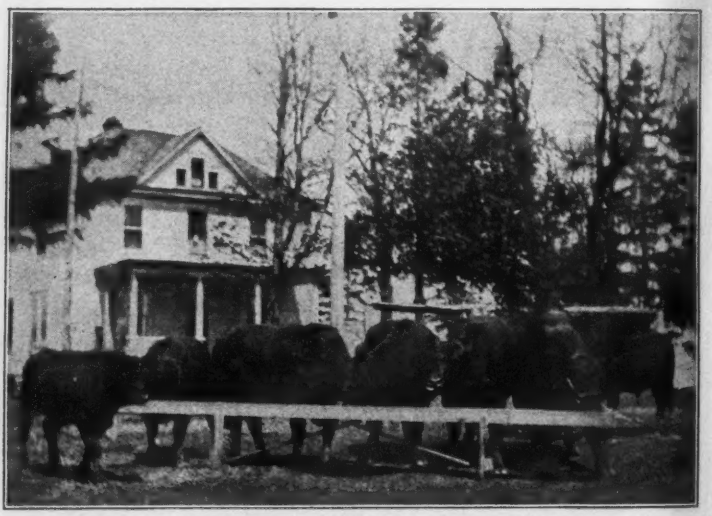

FIG. 13.—An accredited Aberdeen-Angus herd, Minnesota.

whenever possible. After diseased animals are found and removed from the premises, a *very thorough* cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant. The use of disinfectants without first doing the necessary and proper cleaning is ineffective for the reason that the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences can then be sprayed properly with the disinfectant.

FIG. 19.—An accredited Shorthorn herd, North Dakota.

All this means much work but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where live stock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

FIG. 20.—An accredited Hereford herd, Kentucky.

DISPOSAL OF REACTORS.

The disposal of reactors depends largely upon the State laws and live-stock regulations of the State in which the herd belongs. If the animals are pure bred and registered and of unusual merit, they should be segregated, preferably on farms set aside by the State or by the pure-bred cattle associations, for the purpose of retaining tuberculous cattle in quarantine. If the condemned animals are

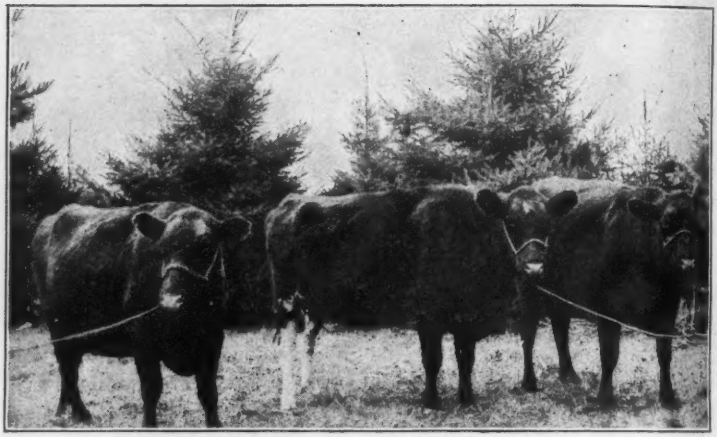

FIG. 21.—An accredited Polled Durham herd, Minnesota.

THE ACCREDITED-HERD PLAN—EVERY CATTLE OWNER ELIGIBLE.

A tuberculosis-free accredited herd is one which has been tuberculin tested by the subcutaneous method or any other approved method under the supervision of the Bureau of Animal Industry, or of a regularly employed veterinary inspector of the State in which cooperative tuberculosis eradication is being conducted.

It is a herd in which no animal affected with tuberculosis has been found upon two annual or three semiannual tests, made as described, and by physical examination.

Owners of tuberculosis-free herds receive a certificate issued by the bureau and the State live-stock sanitary authorities. The certificate is good for one year from the date of the test, unless revoked at an earlier date.

grade cattle, or pure breds not specially valuable for breeding, it will probably be more economical to have them slaughtered than to hold them in quarantine. Of course the fact is recognized that in States and communities where tuberculosis exists extensively the slaughtering of all reactors is impracticable. In such instances the infection can be reduced on all the farms by keeping the tuberculous animals separate from the healthy ones. The tuberculous cattle are kept under quarantine restrictions until no longer profitable; meanwhile the healthy animals are safe from the danger of infection.

RETESTING.

It is rather uncommon for tuberculosis to be eradicated from an infected herd after one tuberculin test. After the removal of reactors the herd should be retested at the expiration of six months, and a second retest may be advisable six months later, but the practice of testing herds more frequently than that is not usually advised. After two or three semiannual tests the herd should not be tested oftener than every 12 months. While the subcutaneous test is considered preferable for gentle cattle, the ophthalmic and intradermal methods of testing may be employed to advantage as adjuncts to it; and it is believed that in some instances herds may be freed of tuberculosis earlier by the judicious use of all three methods. No general outline can be given as to when all three tests should be employed; the matter should be left to the judgment of the veterinarian under whose direction the work is carried on.

MARKING ANIMALS FOR IDENTIFICATION.

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified as affected with tuberculosis. One method that is quite generally used is that of branding; a letter "T" about 2 inches high is branded on the lower jaw, or sometimes it is placed on other parts of the body where it can be seen readily. In addition to the branding it is advisable to tag the reacting animals so that one may be identified from another, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is usually placed in the ear of the animal and contains a serial number as well as the word "Reactor."

Another method that is sometimes used is the punching of a letter "T" out of the ear, and it has been quite satisfactory.

The marking of cattle that have passed the tuberculin test is a matter that is being handled in different ways throughout the United States, and it is believed that the present methods of marking will be improved. In some cases a metal ear tag is used and in others certain marks of identification are tattooed in the ear. Tattooing

has an advantage over the tagging in that it is less expensive and probably more permanent.

It is not often necessary to require special marks on pure-bred registered cattle, as the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking that will show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine so that the origin of those found to be tuberculous on post-mortem examination can be learned would be very desirable, and some experimental work along this line is now being conducted by the bureau in cooperation with owners and packers. The results so far obtained indicate that the tattooing of a number or some mark of identification into the skin of the hog is the most practicable method but of course it entails additional labor and expense which would amount to a great deal if carried on throughout the country. It is hoped a more practicable and economical means of marking swine for identification will be developed in the future, as much good in the campaign for the eradication of tuberculosis in live stock can be accomplished in that way.

Many shipments which contain tuberculous swine are traced back to the farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised, efforts can be directed in eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY.

In addition to the various benefits derived from eradicating tuberculosis, provision for the appraisement of diseased cattle with indemnity for those slaughtered is a further incentive. Federal legislation and supplementary laws in numerous States now divide the burden

WHY THE TUBERCULIN TEST IS HARMLESS.

Tuberculin contains only the sterilized products of the tubercle bacilli. It does not contain any living germ; therefore it is harmless to any animal whether healthy or diseased.

Only diseased animals give typical reactions to the test. The test does not injure animals in a condition of advanced pregnancy, and will not cause them to react if they are free from disease.

Likewise, it does not produce reactions in disease-free animals which have recently calved.

HOW THE WORK OF ERADICATION IS DIVIDED BETWEEN STATE AND GOVERNMENT OFFICIALS AND OTHERS.

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the U. S. Department of Agriculture, the live-stock sanitary officials of the various States, and individual cattle owners. The bureau and the State officials send veterinary inspectors to apply tuberculin tests to the herds of those owners who sign a cooperative agreement, which places their herds jointly under supervision for the control and eradication of the disease.

of loss, so that the Government, the State, and the owner of the cattle all bear a share of it. Briefly, the Federal law provides that the Secretary of Agriculture may reimburse partly owners of animals destroyed on account of tuberculosis in cooperation with States, counties, and municipalities. The bases upon which Federal indemnities are paid are:

1. No payment shall exceed one-third of the difference between the appraised value of such animal and the salvage value.
2. No payment shall exceed the amount paid or to be paid by the State, county, or municipality.
3. In no case shall any payment be more than $25 for any grade animal or more than $50 for any pure-bred animal.
4. No payment shall be made unless the owner has complied with all lawful quarantine regulations.

Legislation regarding indemnities for tuberculous cattle varies somewhat in different States and, for detailed and current information on the subject, the reader is referred to his State live-stock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained by addressing the Bureau of Animal Industry, U. S. Department of Agriculture.

A careful study of figures 4, 6, 7, and 8 in this bulletin will enable the reader to become familiar with the appearance of the parts of the body most commonly affected. He will also see, even more clearly than can be described, that a real danger exists in permitting diseased animals or those of doubtful health to mingle with others. The illustrations of the accredited herds, on the other hand, show the splendid types of cattle which their owners have subjected to the tuberculin test and which have passed it successfully.

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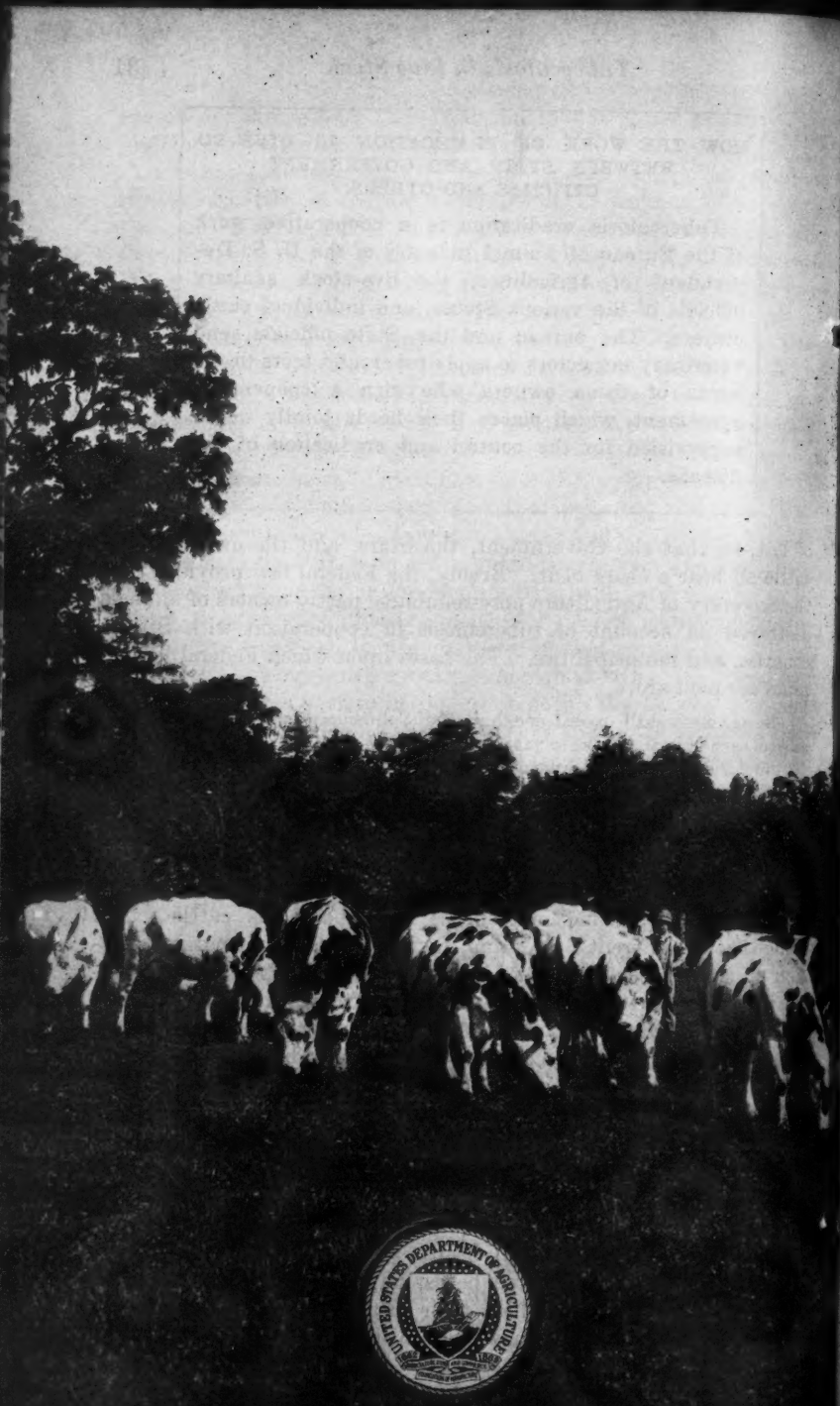

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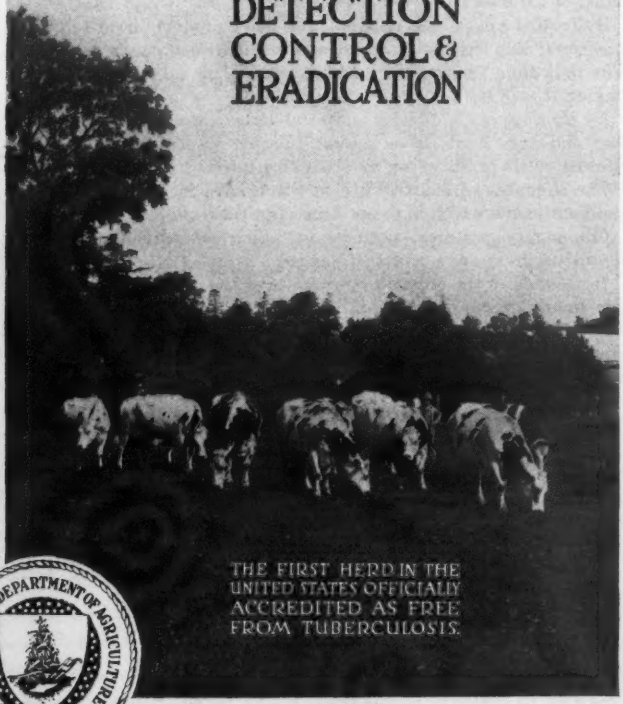
TUBERCULOSIS IN LIVE STOCK

DETECTION CONTROL & ERADICATION



THE FIRST HERD IN THE UNITED STATES OFFICIALLY ACCREDITED AS FREE FROM TUBERCULOSIS.

XUM

HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE.

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

By the addition of an animal that is affected with the disease; therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

By feeding calves with milk or other dairy products from tuberculous cows; this frequently occurs where the owner purchases mixed skim milk from the creamery, and feeds it to his calves without first making it safe by boiling or pasteurization.

By showing cattle at fairs and exhibitions; reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

The shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

Community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

Washington, D. C.

Issued November, 1919
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TUBERCULOSIS IN LIVE STOCK.

DETECTION, CONTROL, AND ERADICATION.

JOHN A. KIERNAN, *Chief*, and ALEXANDER E. WIGHT, *Assistant Chief, Tuberculosis Eradication Division, Bureau of Animal Industry.*

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PRESENT KNOWLEDGE OF TUBERCULOSIS.

PROBABLY no disease affecting either the human race or live stock is better known or has been the object of so much study as tuberculosis. Present knowledge of the disease is derived from many sources, including the work of eminent scientists who discovered its cause, and studies of the numerous ways in which it is spread, of the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1882 by the eminent scientist, Dr. Robert Koch. Thus the test has been known for more than a third of a century. The facts regarding it and other information presented in this bulletin are based upon long experience and results verified many times. The methods recommended to be used in the eradication of tuberculosis have been tried upon large numbers of herds and found to be effectual and practicable.

EARLY ERADICATION IS MOST ECONOMICAL.

Live-stock owners are earnestly requested not to wait until the States and Federal Government come into their localities to eradicate tuberculosis. It would not be possible indeed, at this stage to undertake to eradicate tuberculosis from the live stock of the United States solely through organized official forces established by the respective States and the Federal Government. The area over which tuberculosis has spread is too vast, the herds too numerous, and

funds are insufficient for conducting the work on so extensive a plan even though trained veterinarians were available in sufficient numbers to do the work. Every live-stock owner should be a party to this campaign which has been inaugurated to eradicate tuberculosis. In almost every locality of the United States are veterinarians capable of rendering valuable services to live-stock owners in this great work, and the cost of eradicating is greatly reduced by combating the disease in its early stages. Yet even in badly affected herds eradication can be undertaken with success. There are records of many herds, in which three-fourths of the animals

FIG. 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. Upon application of the tuberculin test, 37, or 82 per cent, of the animals were found to be tuberculous. The germs of the disease may live for months in manure or litter.

were affected with tuberculosis, which eventually were freed from it and afterwards maintained in a healthy condition.

The extirpation of tuberculosis from live stock is important not only from an economic standpoint, but also because a considerable percentage of tuberculosis in the human family, especially among children, is positively due to the consumption of infected milk or other dairy products from tuberculous cows. It is eminently proper for the respective State governments to expend funds for the maintenance of tuberculosis sanitariums for the care of persons afflicted with that disease, and likewise it is extremely important to use vigorous measures to check the marketing of germ-laden milk. While it is true that proper pasteurization of milk destroys the living organisms

of tuberculosis, a large part of the milk consumed daily is not pasteurized, and some of the milk so treated is not always made entirely safe.

TUBERCULOSIS A DECEPTIVE DISEASE.

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among the live-stock owners, who would insist upon its immediate eradication; but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals, many people believe that it does comparatively little damage among live stock. Contrary to such opinions, however, the loss from tuberculosis is one of the heaviest taxes imposed upon our live-stock industry, amounting, probably, to at least $40,000,000 a year in the United States.

PREVALENCE OF TUBERCULOSIS.

In every State and Territory in the Union there is some tuberculosis among cattle and swine, though the degree varies considerably. In some States it probably exists quite extensively, the percentage varying from 5 to 30 per cent of the cattle population, while in certain others investigations indicate that less than 1 per cent of the total of beef and dairy cattle are tuberculous.

Tuberculosis is known to exist also quite extensively among cattle and swine in all the European countries; in fact, no part of the world is known to be free from it absolutely. There are, however, some restricted regions where its presence is not known, or it exists to but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States, tuberculosis among live stock in those regions was unknown so far as we know. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but live-stock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the live-stock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

In some localities in the West, where dairying has developed extensively, it is now known that carload lots of cows purchased in other States have contained 50 per cent or more of tuberculous animals. Some herds of beef cattle in our western country have become contaminated with the disease by placing among them tuberculous pure-bred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is to-day. Consequently in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick. Therefore there is probably less tuberculosis among the herds of the Southern States than in any other part of the Nation. This favorable condition should be taken advantage of, for in all probability the live-stock industry will reach a high development in that area in future years. It is especially important that the herds of the Southern States be protected by permitting only tuberculosis-free animals to enter.

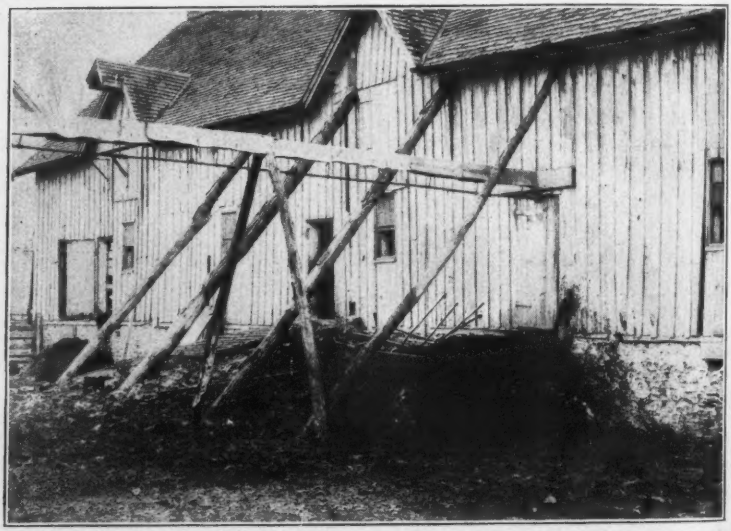

FIG. 2.—An insanitary barn. Nearly all the cows kept in it were tuberculous. The stone foundation wall retains about 2 feet of liquid manure which contains millions of tubercle germs. Premises of this character can not be kept sanitary.

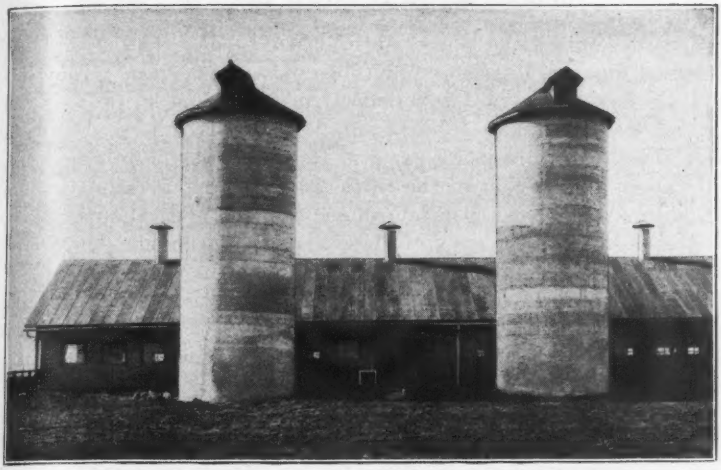

FIG. 3.—A modern sanitary barn. Note ventilators and liberal window space.

HOW THE DISEASE SPREADS IN A HERD.

The tuberculous cow is the greatest source of danger to healthy cattle. Any reacting cattle not promptly removed from the herd constitute a source of constant infection.

Tuberculous cattle, sooner or later, begin to give off the germs of the disease. These germs escape by the mouth, nose, and bowels, in the milk, and other discharges. The discharged germs are carried in the air for a time until they fall to the ground.

Animals in adjoining stalls may take in the germs in the feed they eat and thus contract the disease. Continuous water troughs in barns containing diseased cattle are a source of danger. Drinking holes containing material from infected animals are likewise dangerous.

Failure to clean and disinfect the premises occupied by the diseased cattle constitutes another source of danger. Infected milking tubes and the practice of feeding calves with raw milk from tuberculous cows are other means by which tuberculosis spreads in a herd.

LOSSES OF MEAT FOOD PRODUCTS.

Records kept by the Meat Inspection Division of the bureau show the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 per cent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 per cent of these classes of animals slaughtered each year in the United States do not appear in these records. It is known also that the percentage of tuberculosis is greater in the uninspected animals. In view of these points the losses shown in the following table are believed to be scarcely one-half of the total loss throughout the country.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is placed aside for further examination. If the disease is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed and the remainder is passed. It will be noted that such is the case in most carcasses retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In the animals that are retained and when the disease is not extensive enough to cause condemnation of the entire carcass, the disease is in most cases in the early stages. Had the animals been allowed to live for possibly only a short time longer, the disease would have progressed until all the carcass would have to be considered diseased. In others the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and endanger healthy cattle and swine.

HOW TO PROCEED TO MAKE CERTAIN THAT CATTLE AND SWINE ARE FREE FROM TUBERCULOSIS.

Have a competent veterinarian apply the tuberculin test. Remove all reactors promptly, and disinfect the premises immediately after the removal of the reacting cattle.

Do not feed any infected dairy products to swine or young cattle.

Retest the herd with tuberculin once a year.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger, State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from that farm.

TABLE 1.—*Number of cattle and swine slaughtered, and those retained and condemned on account of tuberculosis at establishments where Federal meat inspection is maintained.*

Fiscal year.	Cattle.			Swine.		
	Slaughtered.	Retained.	Condemned.	Slaughtered.	Retained.	Condemned.
1907 [1]	5,867,642	24,876	17,117	26,189,026	362,445	48,544
1908	7,116,275	68,395	24,371	35,113,077	719,279	77,554
1909	7,325,337	100,650	24,525	35,427,931	860,425	45,113
1910	7,962,189	123,501	27,638	27,656,021	792,176	28,880
1911	7,781,030	133,551	27,186	29,916,363	1,117,789	31,517
1912	7,532,005	160,122	35,273	34,966,378	1,643,100	42,267
1913	7,155,816	152,560	33,001	32,287,538	1,809,751	47,632
1914	6,724,117	143,699	29,738	33,289,705	2,201,005	48,252
1915	6,964,402	158,239	32,644	36,247,958	2,774,835	66,023
1916	7,404,288	190,991	37,085	40,482,799	3,687,817	74,109
1917	9,299,489	218,928	46,351	40,210,847	3,978,168	76,807
1918	10,938,287	222,787	40,692	35,449,247	3,494,587	59,740
1919	11,241,991	205,698	37,600	44,298,389	4,103,376	65,837
1920	9,709,819	200,647	37,492	38,981,914	4,260,719	65,609
1921	8,179,572	173,658	33,328	37,702,866	4,693,305	64,830
1922	7,871,457	213,606	39,434	39,416,439	5,640,081	70,304

[1] Covers 9 months from October 1, 1906, to June 30, 1907.

CAUSE OF TUBERCULOSIS.

The direct and primary cause of tuberculosis is a rod-shaped germ which can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or live stock is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures, paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other inclosures which contained tuberculous animals before healthy ones are again placed in them.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose

the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuberculosis among the stock whenever the germs are present. Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED WITH TUBERCULOSIS.

The tuberculous cow is the greatest source of danger to healthy cattle, and inasmuch as it can not be determined just when that animal becomes a "spreader" of the germs, unless daily microscopic tests are made of the discharges from the body, and the milk is also examined microscopically, it is unsafe to keep it with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming into contact with affected animals than in any other

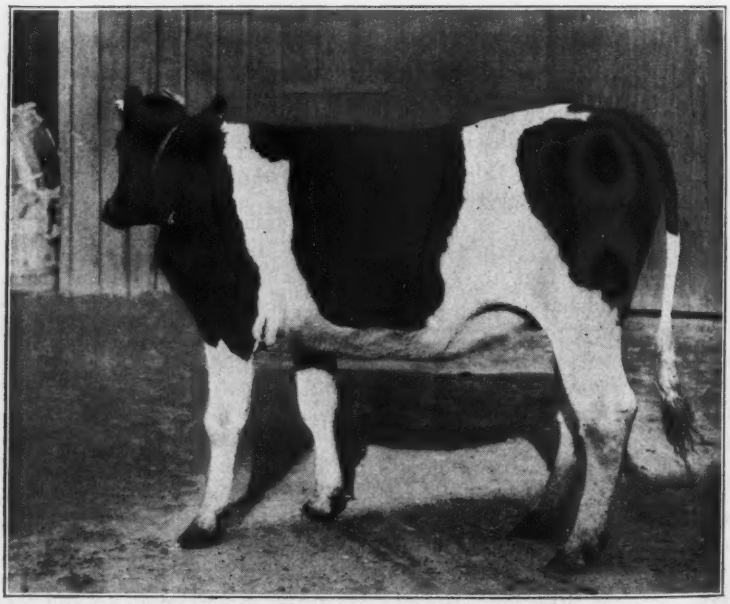

FIG. 4.—A tuberculous heifer. The gland at the shoulder was diseased and discharging tuberculous pus.

way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

The continuous water trough in barns is also accountable to a very large extent for spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which infected milk or the washings from infected milk cans have been dumped may also be a source of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected frequently by drinking milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE MAY BECOME INFECTED.

The tuberculous cow is not only a menace to other cattle but is also the commonest source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the development of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record, also, in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are kept on the same farm, some of the latter are tuberculous. Eradication of tuberculosis from cattle, it is believed, will greatly reduce its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuber-

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culosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another.

SYMPTOMS OF TUBERCULOSIS.

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms. Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions

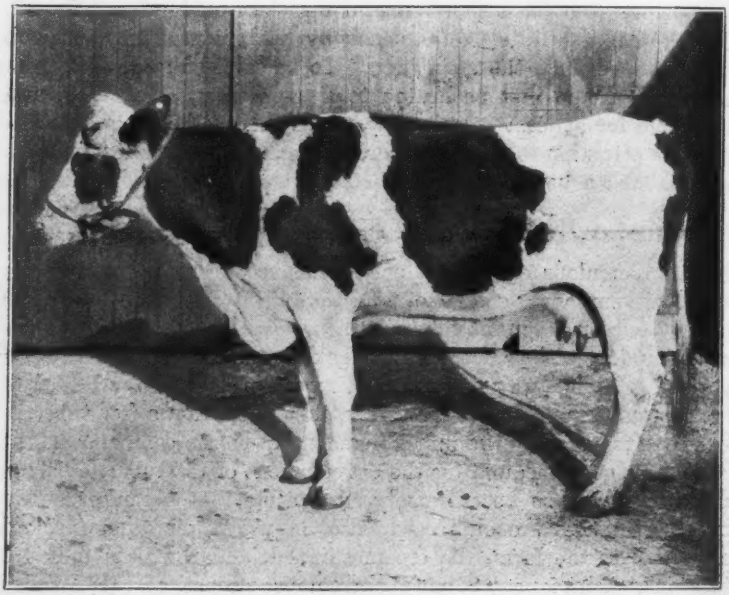

FIG. 5.—A reacting cow that was constantly "bloating." The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating.

which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body, an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands

of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening, as shown in figure 4. Animals affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an animal are affected, it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased, the animal often develops bloat (fig. 5). Diarrhea is often evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

FIG. 6.—Part of a tuberculous udder showing well-developed lesions.

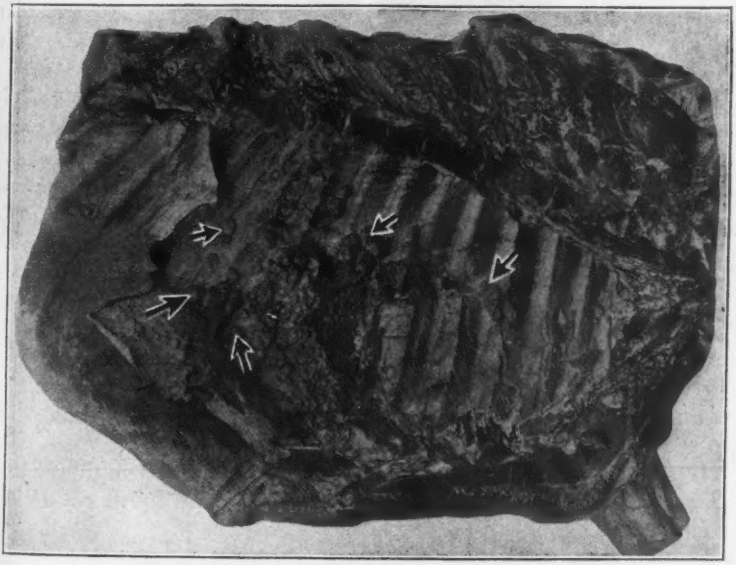

FIG. 7.—Beef carcass showing tuberculous nodules on ribs.

METHODS OF DIAGNOSIS.

Microscopic examinations of sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of experience the tuberculin test is now considered to be the most practicable and satisfactory way of discovering the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

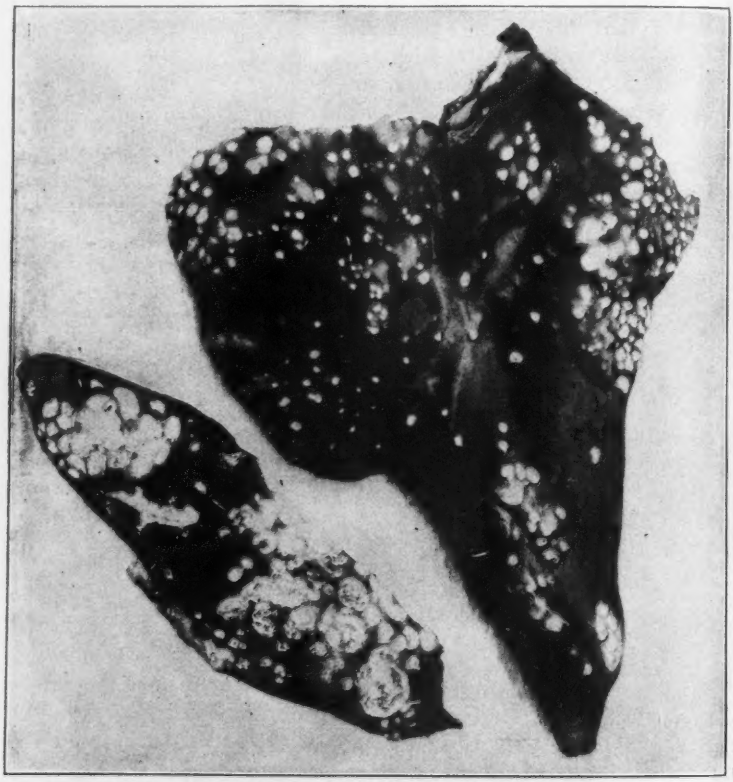

FIG. 8.—Liver and spleen showing extensive lesions of tuberculosis.

THE TUBERCULIN TEST.

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and in the hands of skillful persons, it is a reliable agent for detecting tuberculosis in animals. It contains no living tubercle bacilli but is a product of the growth of tubercle bacilli properly mixed with a substance on which it has grown and properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used.

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action. Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to its application at another time; therefore it may be misused by unscrupulous persons.

THE SUBCUTANEOUS TEST (UNDER THE SKIN).

The subcutaneous test is made by injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to measure the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are measured at least 3 times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the person applying the test, and a careful observance of any clinical changes is always important in determining the result. It can not be set forth too strongly that the test, including the two following methods, should be attempted only by those who are properly qualified to do the work.

THE INTRADERMIC TEST (INTO THE SKIN).

The intradermic test for detecting tuberculosis is used to a considerable extent because of its convenience. When made by those who have become skilled in its application, it is very accurate. In this test the tuberculin is injected between the layers of the skin, only a few drops being used, and it is usually applied in the region at

the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine, and when so used the tuberculin is applied into the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is usually observed from 72 to 120 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced person.

THE OPHTHALMIC TEST (INTO THE EYE).

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the previously described methods. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the

RELIABILITY OF THE PRINCIPAL TUBERCULIN TESTS.

The subcutaneous test is made by injecting, under the skin, a small quantity of tuberculin. Carefully and conscientiously applied, with good judgment exercised in both its administration and interpretation, it is wholly effective.

The intradermic test is especially suitable for range cattle or animals whose movements are difficult to control, and in area work. In this test the tuberculin is injected between the layers of the skin.

The ophthalmic test, or so-called "eye test," is not at present accepted for testing cattle for interstate shipment, though it has value as a check test and is recognized for that purpose. It is applied by placing the ophthalmic tuberculin in one eye, using the other as a check. The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit. In all cases the tests, used either alone or in combination, should be applied by capable persons familiar with tuberculin testing.

FIG. 9.—Part of a herd of 69 cattle, 30 per cent tuberculous in 1917, 5 per cent tuberculous in 1918, 100 per cent free from tuberculosis in 1919. The herd is now accredited.

disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from

FIG. 10.—How a herd may become reinfected with tuberculosis. This herd was free from tuberculosis for a number of years. During 1917, 4 cattle were purchased in another State and placed in the herd without proper tuberculin test. When official test was made, December, 1917, 5 reactors were found. Three of the reactors were slaughtered and 2 kept in the herd. At the next test, January, 1919, 11 reactors and 2 suspects were in the herd of 28 cattle.

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the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

POST-MORTEM APPEARANCES.

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs. The lesions are of various sizes and may contain pus, either soft or hard; many times it is gritty. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities. Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands, to some extent, are usually affected, and, when cut into, show diseased areas characteristic of tuberculosis.

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible for even the most skillful person in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals reacting to the test were not affected with tuberculosis to some extent even though some were very slight.

METHODS OF ERADICATION.

Cattle owners who do not know whether tuberculosis exists among their animals should ascertain the fact by having them tuberculin-tested and physically examined by a qualified veterinarian. In many cases thousands of dollars and very valuable breeding animals might have been saved by taking up tuberculosis-eradication work in time. Three main projects comprise the general campaign of eradication, as follows:

1. Eradication of tuberculosis from pure-bred herds of cattle.
2. Eradication of tuberculosis from circumscribed areas.
3. Eradication of tuberculosis from swine.

It is important to eradicate tuberculosis from pure-bred herds of cattle at the earliest possible date because the spread of the disease is greater among such animals than among grade cattle. The reason is plain; pure-bred animals are shipped extensively to every part of the United States for breeding purposes. A pure-bred bull or cow may be shipped from Maine to Texas, or from the State of Washington to Florida. If it is diseased and is introduced into a healthy herd, it not only fails to fulfill the purpose for which it was intended—the upbreeding of the herd—but it actually causes heavy damage by spreading the disease to healthy animals.

FIG. 11.—This Hereford herd was freed from tuberculosis within 3 years. The first test, in 1916, showed the herd to be 10 per cent tuberculous. The reactors were removed and in 1918 all the 62 animals in the herd were found to be healthy.

ACCREDITED-HERD OR HONOR-ROLL PLAN.

The breeders of pure-bred registered cattle fully appreciated the above-mentioned fact when, together with the live-stock sanitary officials of practically all the States, they adopted what is known as the accredited-herd plan, the principles of which are that herds found to be free from tuberculosis on two successive annual tests are placed on the Honor Roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of one year. This plan is becoming well known to breeders throughout the United States. The progress of the accredited-herd plan is given in Table 2.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for pure breds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly

tuberculin tested. To make a satisfactory test all the cattle should be in normal condition and, so far as practicable, the cattle should be stabled under usual conditions and among usual surroundings. Feeding and watering should be conducted in the customary manner, with the exception that feed and water should be given only after the temperature has been taken. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

TABLE 2.—*Status of cooperative tuberculosis-eradication work, including all herds under supervision, September 1, 1922.*

State.	Passed one test.		Accredited.		Under supervision.	
	Herds.	Cattle.	Herds.	Cattle.	Herds.	Cattle.
Alabama	660	17,144	78	3,202	798	23,211
Arizona	19	1,445			32	1,510
Arkansas	39	845	35	1,084	81	2,000
California	368	3,694	0	0	467	8,914
Colorado	30	760	1	37	47	1,480
Connecticut	553	9,977	104	2,569	832	18,563
Delaware	1,060	4,430	230	1,671	2,009	10,687
District of Columbia	313	342	30	797	345	1,166
Florida	3,288	25,198	100	3,575	4,184	47,499
Georgia	2,068	30,494	22	1,727	2,270	40,831
Idaho	5,523	44,757	127	4,256	6,086	55,878
Illinois	740	13,463	407	9,332	4,210	51,470
Indiana	10,158	71,990	1,535	25,210	12,962	118,880
Iowa	4,024	63,798	1,059	28,298	6,549	135,701
Kansas	433	11,200	398	12,400	1,016	32,219
Kentucky	6,384	47,112	206	5,969	7,901	66,261
Louisiana	542	11,993	69	3,238	639	18,528
Maine	7,383	63,198	634	7,852	8,017	71,050
Maryland	1,986	18,936	408	8,077	3,907	37,649
Massachusetts	76	2,083	63	2,363	242	7,638
Michigan	18,519	145,384	395	7,650	21,256	181,752
Minnesota	2,245	53,235	1,658	37,511	4,752	110,360
Mississippi	354	11,095	140	3,282	672	15,882
Missouri	20,715	201,591	410	12,808	21,799	231,592
Montana	11,160	141,182	120	6,826	12,117	175,100
Nebraska	8,799	106,135	234	6,536	10,913	146,604
Nevada	1,533	8,951	9	963	1,884	18,612
New Hampshire	558	6,120	65	1,718	871	13,238
New Jersey	129	1,919	79	2,095	332	8,723
New Mexico	749	5,832	0	0	941	7,051
New York	8,156	92,369	707	14,472	10,555	247,555
North Carolina	29,318	102,825	277	5,604	30,219	110,035
North Dakota	3,716	65,395	809	17,837	5,626	110,338
Ohio	1,674	23,267	953	16,477	3,180	51,425
Oklahoma	376	9,879	197	6,790	1,150	23,478
Oregon	9,888	95,427	180	4,451	10,068	99,878
Pennsylvania	1,029	14,416	1,358	22,391	2,638	41,757
Rhode Island	22	607	14	307	48	1,344
South Carolina	943	11,966	79	2,656	2,002	18,537
South Dakota	281	7,343	257	5,843	650	17,146
Tennessee	681	13,550	223	8,696	6,565	62,824
Texas	41	1,457	71	2,873	243	18,007
Utah	6,398	25,031	77	2,457	7,041	46,043
Vermont	2,126	31,584	1,396	23,935	4,403	76,486
Virginia	1,294	14,284	736	16,846	2,439	42,935
Washington	7,015	55,945	128	2,879	7,994	66,739
West Virginia	2,143	18,154	213	4,608	2,620	28,114
Wisconsin	3,011	52,590	1,820	41,151	5,800	134,141
Wyoming	3,179	31,259	3	110	3,499	35,945
Total	191,609	1,791,651	18,114	401,429	244,871	2,892,776

FIG. 12.—An accredited Jersey herd, Minnesota.

PRINCIPAL BENEFITS OF COMPLETE ERADICATION OF TUBERCULOSIS.

Increased value of individual animal and increased herd value.

Ability to ship interstate from accredited herds without further testing for a period of one year.

The owner's name being listed in pamphlets published by the respective States and the Bureau of Animal Industry.

Confidence by those who desire to purchase cattle to add to their herds.

Satisfaction of knowing that the dairy products offered for sale are free from diseased germs.

Elimination of economic losses caused by the disease.

ERADICATION FROM AREAS.

The unit territory to be worked will depend mainly upon the extent to which the disease has spread. In some States practically every county contains numerous tuberculous herds, so that, to control the disease effectively, all the herds must be tuberculin tested. In other States, however, the disease is confined to the beef and dairy herds recently established or to which new animals have lately been added. In the latter case it would not be necessary to test all the cattle, but the examination of the herds should be sufficient to demonstrate most satisfactorily that no diseased herds are overlooked. This can be done by testing several herds in each section of the county wherever there is a suspicion that the disease may exist.

As a general plan, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county should pay (1) part of the expense of exterminating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it is advisable to clean up the herds within a township or possibly one-third or one-half of the area. The progress depends upon the degree of infection found and the cooperation furnished by the owners.

FIG. 13.—An accredited Guernsey herd, Wisconsin.

FIG. 14.—An accredited Ayrshire herd, West Virginia.

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin tested; of the total number, 321 cattle, or 18.87 per cent, were tuberculous. The reactors were removed from the herds and, in most instances, were slaughtered. The infected barns, sheds, and premises were cleaned and disinfected. Each year since the inauguration of the campaign all the cattle have been tuberculin tested with the result that the infection has almost disappeared.

There are States in which tuberculosis exists to less than 1 per cent among all the bovine population. The plan of carrying on eradication in several counties at the same time in those States is practicable and is being conducted in a number of States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make, it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The larger herds, especially around cities and those supplying milk locally and for shipment to other cities, should be tested before the small lots. If it is known that the herds are but slightly infected, the intradermic method should be employed, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermic test, the entire herd should be tested subcutaneously within a short time. The ophthalmic test may also be used in conjunction with the subcutaneous in "check" testing

FIG. 15.—An accredited herd of pure-bred Milking Shorthorns, Virginia.

herds. General experience shows that it is sound practice, if there is any doubt, to use all three methods of testing with tuberculin. Such a policy is especially applicable to cattle which have been tested frequently, and among herds which are or have been extensively diseased.

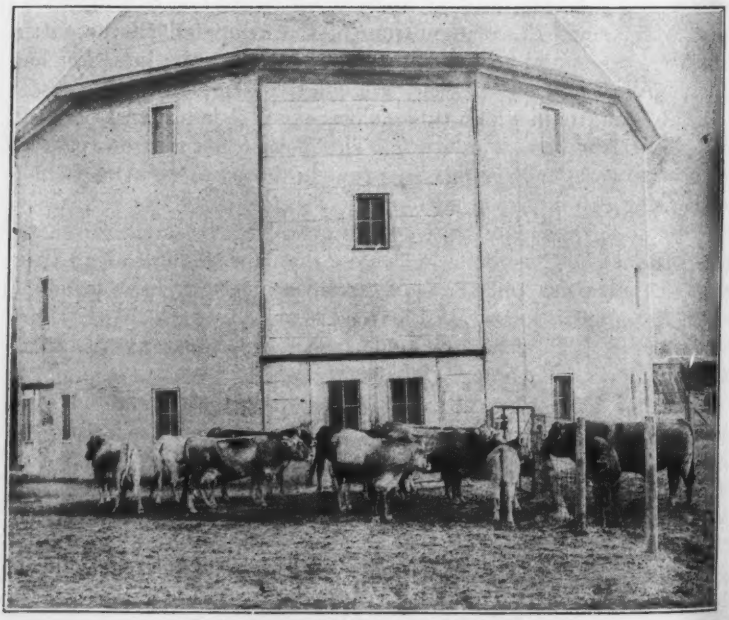

FIG. 16.—An accredited Brown Swiss herd, Indiana.

ERADICATION FROM SWINE.

With the gradual elimination of tuberculosis from cattle, the disease among swine will grow correspondingly smaller. It is not necessary to tuberculin test all the swine herds because, with the exception of valuable breeding animals, it is more economical to slaughter the diseased ones when fat than to undertake to exterminate the disease in any other way.

In the case of suspected, valuable pure-bred swine, their freedom from tuberculosis can be determined definitely by the intradermic method, which is practicable and reliable.

The injection is near the base of the left ear; the other ear acts as a check for comparison. A reaction is manifested by a swelling in the

FIG. 17.—An accredited Red Poll herd, Virginia.

region where the tuberculin was injected. The swelling may appear any time from the 24th to the 104th hour after injection and will remain for several days. As in the case of cattle, diseased swine should be removed from the farm, and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

MEASURES OF PREVENTION.

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regu-

lating the movements of cattle, and recently, with that object in view, action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the live-stock owner. It is he who must take a very important part all through the campaign of tuberculosis eradication, and if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped

FIG. 18.—An accredited Aberdeen-Angus herd, Minnesota.

whenever possible. After diseased animals are found and removed from the premises, a *very thorough* cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant. The use of disinfectants without first doing the necessary and proper cleaning is ineffective for the reason that the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences can then be sprayed properly with the disinfectant.

FIG. 19.—An accredited Shorthorn herd, North Dakota.

All this means much work but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where live stock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

FIG. 20.—An accredited Hereford herd, Kentucky.

DISPOSAL OF REACTORS.

The disposal of reactors depends largely upon the State laws and live-stock regulations of the State in which the herd belongs. If the animals are pure bred and registered and of unusual merit, they should be segregated, preferably on farms set aside by the State or by the pure-bred cattle associations, for the purpose of retaining tuberculous cattle in quarantine. If the condemned animals are

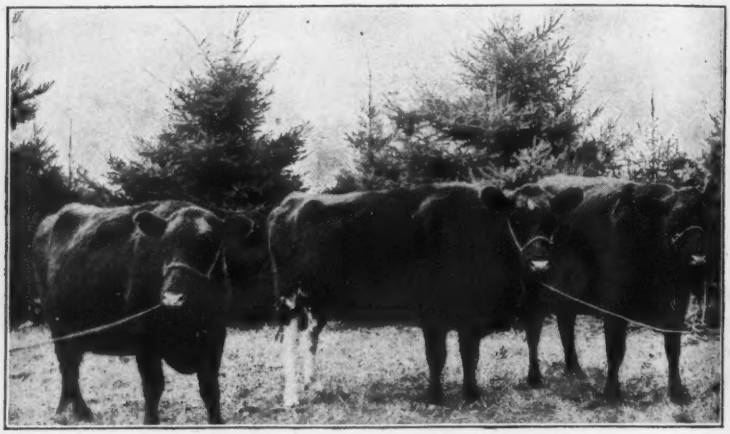

FIG. 21.—An accredited Polled Durham herd, Minnesota.

THE ACCREDITED-HERD PLAN—EVERY CATTLE OWNER ELIGIBLE.

A tuberculosis-free accredited herd is one which has been tuberculin tested by the subcutaneous method or any other approved method under the supervision of the Bureau of Animal Industry, or of a regularly employed veterinary inspector of the State in which cooperative tuberculosis eradication is being conducted.

It is a herd in which no animal affected with tuberculosis has been found upon two annual or three semiannual tests, made as described, and by physical examination.

Owners of tuberculosis-free herds receive a certificate issued by the bureau and the State live-stock sanitary authorities. The certificate is good for one year from the date of the test, unless revoked at an earlier date.

grade cattle, or pure breds not specially valuable for breeding, it will probably be more economical to have them slaughtered than to hold them in quarantine. Of course the fact is recognized that in States and communities where tuberculosis exists extensively the slaughtering of all reactors is impracticable. In such instances the infection can be reduced on all the farms by keeping the tuberculous animals separate from the healthy ones. The tuberculous cattle are kept under quarantine restrictions until no longer profitable; meanwhile the healthy animals are safe from the danger of infection.

RETESTING.

It is rather uncommon for tuberculosis to be eradicated from an infected herd after one tuberculin test. After the removal of reactors the herd should be retested at the expiration of six months, and a second retest may be advisable six months later, but the practice of testing herds more frequently than that is not usually advised. After two or three semiannual tests the herd should not be tested oftener than every 12 months. While the subcutaneous test is considered preferable for gentle cattle, the ophthalmic and intradermic methods of testing may be employed to advantage as adjuncts to it; and it is believed that in some instances herds may be freed of tuberculosis earlier by the judicious use of all three methods. No general outline can be given as to when all three tests should be employed; the matter should be left to the judgment of the veterinarian under whose direction the work is carried on.

MARKING ANIMALS FOR IDENTIFICATION.

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified as affected with tuberculosis. One method that is quite generally used is that of branding; a letter "T" about 2 inches high is branded on the lower jaw, or sometimes it is placed on other parts of the body where it can be seen readily. In addition to the branding it is advisable to tag the reacting animals so that one may be identified from another, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is usually placed in the ear of the animal and contains a serial number as well as the word "Reactor."

Another method that is sometimes used is the punching of a letter "T" out of the ear, and it has been quite satisfactory.

The marking of cattle that have passed the tuberculin test is a matter that is being handled in different ways throughout the United States, and it is believed that the present methods of marking will be improved. In some cases a metal ear tag is used and in others certain marks of identification are tattooed in the ear. Tattooing

has an advantage over the tagging in that it is less expensive and probably more permanent.

It is not often necessary to require special marks on pure-bred registered cattle, as the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking that will show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine so that the origin of those found to be tuberculous on post-mortem examination can be learned would be very desirable, and some experimental work along this line is now being conducted by the bureau in cooperation with owners and packers. The results so far obtained indicate that the tattooing of a number or some mark of identification into the skin of the hog is the most practicable method but of course it entails additional labor and expense which would amount to a great deal if carried on throughout the country. It is hoped a more practicable and economical means of marking swine for identification will be developed in the future, as much good in the campaign for the eradication of tuberculosis in live stock can be accomplished in that way.

Many shipments which contain tuberculous swine are traced back to the farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised, efforts can be directed in eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY.

In addition to the various benefits derived from eradicating tuberculosis, provision for the appraisement of diseased cattle with indemnity for those slaughtered is a further incentive. Federal legislation and supplementary laws in numerous States now divide the burden

WHY THE TUBERCULIN TEST IS HARMLESS.

Tuberculin contains only the sterilized products of the tubercle bacilli. It does not contain any living germ; therefore it is harmless to any animal whether healthy or diseased.

Only diseased animals give typical reactions to the test. The test does not injure animals in a condition of advanced pregnancy, and will not cause them to react if they are free from disease.

Likewise, it does not produce reactions in disease-free animals which have recently calved.

HOW THE WORK OF ERADICATION IS DIVIDED BETWEEN STATE AND GOVERNMENT OFFICIALS AND OTHERS.

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the U. S. Department of Agriculture, the live-stock sanitary officials of the various States, and individual cattle owners. The bureau and the State officials send veterinary inspectors to apply tuberculin tests to the herds of those owners who sign a cooperative agreement, which places their herds jointly under supervision for the control and eradication of the disease.

of loss, so that the Government, the State, and the owner of the cattle all bear a share of it. Briefly, the Federal law provides that the Secretary of Agriculture may reimburse partly owners of animals destroyed on account of tuberculosis in cooperation with States, counties, and municipalities. The bases upon which Federal indemnities are paid are:

1. No payment shall exceed one-third of the difference between the appraised value of such animal and the salvage value.
2. No payment shall exceed the amount paid or to be paid by the State, county, or municipality.
3. In no case shall any payment be more than $25 for any grade animal or more than $50 for any pure-bred animal.
4. No payment shall be made unless the owner has complied with all lawful quarantine regulations.

Legislation regarding indemnities for tuberculous cattle varies somewhat in different States and, for detailed and current information on the subject, the reader is referred to his State live-stock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained by addressing the Bureau of Animal Industry U. S. Department of Agriculture.

A careful study of figures 4, 6, 7, and 8 in this bulletin will enable the reader to become familiar with the appearance of the parts of the body most commonly affected. He will also see, even more clearly than can be described, that a real danger exists in permitting diseased animals or those of doubtful health to mingle with others. The illustrations of the accredited herds, on the other hand, show the splendid types of cattle which their owners have subjected to the tuberculin test and which have passed it successfully.

XUM

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This bulletin is a contribution from—

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Division of Tuberculosis Eradication	JOHN A. KIERNAN, *Chief.*

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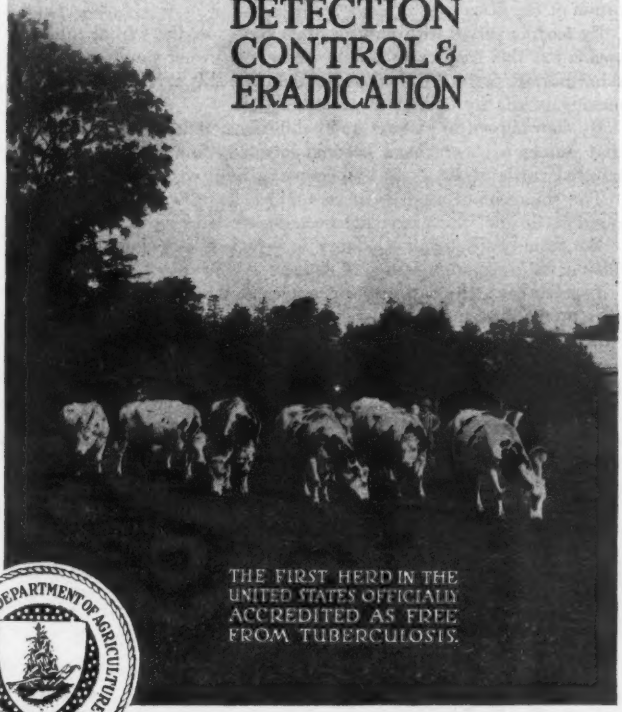
TUBERCULOSIS IN LIVE STOCK

DETECTION CONTROL & ERADICATION



THE FIRST HERD IN THE UNITED STATES OFFICIALLY ACCREDITED AS FREE FROM TUBERCULOSIS.

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HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE.

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

By the addition of an animal that is affected with the disease; therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

By feeding calves with milk or other dairy products from tuberculous cows; this frequently occurs where the owner purchases mixed skim milk from the creamery, and feeds it to his calves without first making it safe by boiling or pasteurization.

By showing cattle at fairs and exhibitions; reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

The shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

Community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

Washington, D. C.

Issued November, 1919
Slightly revised November, 1923

TUBERCULOSIS IN LIVE STOCK.

DETECTION, CONTROL, AND ERADICATION.

JOHN A. KIERNAN, *Chief*, and ALEXANDER E. WIGHT, *Assistant Chief, Tuberculosis Eradication Division, Bureau of Animal Industry.*

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PRESENT KNOWLEDGE OF TUBERCULOSIS.

PROBABLY no disease affecting either the human race or live stock is better known or has been the object of so much study as tuberculosis. Present knowledge of the disease is derived from many sources, including the work of eminent scientists who discovered its cause, and studies of the numerous ways in which it is spread, of the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1882 by the eminent scientist, Dr. Robert Koch. Thus the test has been known for more than a third of a century. The facts regarding it and other information presented in this bulletin are based upon long experience and results verified many times. The methods recommended to be used in the eradication of tuberculosis have been tried upon large numbers of herds and found to be effectual and practicable.

EARLY ERADICATION IS MOST ECONOMICAL.

Live-stock owners are earnestly requested not to wait until the States and Federal Government come into their localities to eradicate tuberculosis. It would not be possible indeed, at this stage to undertake to eradicate tuberculosis from the live stock of the United States solely through organized official forces established by the respective States and the Federal Government. The area over which tuberculosis has spread is too vast, the herds too numerous, and

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funds are insufficient for conducting the work on so extensive a plan even though trained veterinarians were available in sufficient numbers to do the work. Every live-stock owner should be a party to this campaign which has been inaugurated to eradicate tuberculosis. In almost every locality of the United States are veterinarians capable of rendering valuable services to live-stock owners in this great work, and the cost of eradicating is greatly reduced by combating the disease in its early stages. Yet even in badly affected herds eradication can be undertaken with success. There are records of many herds, in which three-fourths of the animals

FIG. 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. Upon application of the tuberculin test, 37, or 82 per cent, of the animals were found to be tuberculous. The germs of the disease may live for months in manure or litter.

were affected with tuberculosis, which eventually were freed from it and afterwards maintained in a healthy condition.

The extirpation of tuberculosis from live stock is important not only from an economic standpoint, but also because a considerable percentage of tuberculosis in the human family, especially among children, is positively due to the consumption of infected milk or other dairy products from tuberculous cows. It is eminently proper for the respective State governments to expend funds for the maintenance of tuberculosis sanitariums for the care of persons afflicted with that disease, and likewise it is extremely important to use vigorous measures to check the marketing of germ-laden milk. While it is true that proper pasteurization of milk destroys the living organisms

of tuberculosis, a large part of the milk consumed daily is not pasteurized, and some of the milk so treated is not always made entirely safe.

TUBERCULOSIS A DECEPTIVE DISEASE.

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among the live-stock owners, who would insist upon its immediate eradication; but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals, many people believe that it does comparatively little damage among live stock. Contrary to such opinions, however, the loss from tuberculosis is one of the heaviest taxes imposed upon our live-stock industry, amounting, probably, to at least $40,000,000 a year in the United States.

PREVALENCE OF TUBERCULOSIS.

In every State and Territory in the Union there is some tuberculosis among cattle and swine, though the degree varies considerably. In some States it probably exists quite extensively, the percentage varying from 5 to 30 per cent of the cattle population, while in certain others investigations indicate that less than 1 per cent of the total of beef and dairy cattle are tuberculous.

Tuberculosis is known to exist also quite extensively among cattle and swine in all the European countries; in fact, no part of the world is known to be free from it absolutely. There are, however, some restricted regions where its presence is not known, or it exists to but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States, tuberculosis among live stock in those regions was unknown so far as we know. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but live-stock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the live-stock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

In some localities in the West, where dairying has developed extensively, it is now known that carload lots of cows purchased in other States have contained 50 per cent or more of tuberculous animals. Some herds of beef cattle in our western country have become contaminated with the disease by placing among them tuberculous pure-bred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is to-day. Consequently in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick. Therefore there is probably less tuberculosis among the herds of the Southern States than in any other part of the Nation. This favorable condition should be taken advantage of, for in all probability the live-stock industry will reach a high development in that area in future years. It is especially important that the herds of the Southern States be protected by permitting only tuberculosis-free animals to enter.

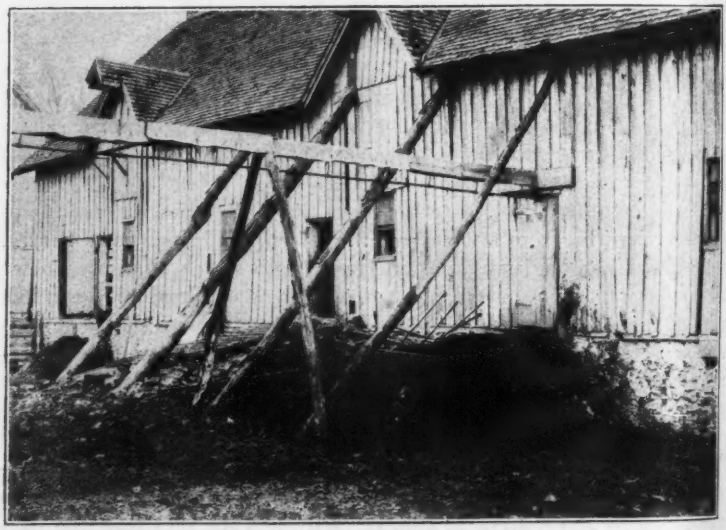

FIG. 2.—An insanitary barn. Nearly all the cows kept in it were tuberculous. The stone foundation wall retains about 2 feet of liquid manure which contains millions of tubercle germs. Premises of this character can not be kept sanitary.

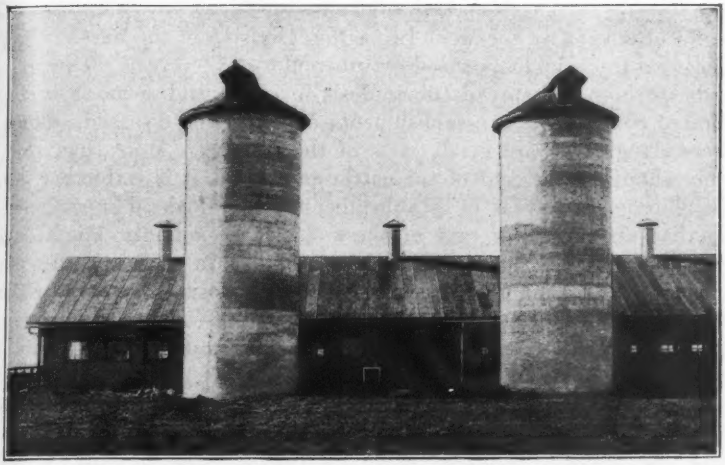

FIG. 3.—A modern sanitary barn. Note ventilators and liberal window space.

HOW THE DISEASE SPREADS IN A HERD.

The tuberculous cow is the greatest source of danger to healthy cattle. Any reacting cattle not promptly removed from the herd constitute a source of constant infection.

Tuberculous cattle, sooner or later, begin to give off the germs of the disease. These germs escape by the mouth, nose, and bowels, in the milk, and other discharges. The discharged germs are carried in the air for a time until they fall to the ground.

Animals in adjoining stalls may take in the germs in the feed they eat and thus contract the disease. Continuous water troughs in barns containing diseased cattle are a source of danger. Drinking holes containing material from infected animals are likewise dangerous.

Failure to clean and disinfect the premises occupied by the diseased cattle constitutes another source of danger. Infected milking tubes and the practice of feeding calves with raw milk from tuberculous cows are other means by which tuberculosis spreads in a herd.

LOSSES OF MEAT FOOD PRODUCTS.

Records kept by the Meat Inspection Division of the bureau show the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 per cent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 per cent of these classes of animals slaughtered each year in the United States do not appear in these records. It is known also that the percentage of tuberculosis is greater in the uninspected animals. In view of these points the losses shown in the following table are believed to be scarcely one-half of the total loss throughout the country.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is placed aside for further examination. If the disease is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed and the remainder is passed. It will be noted that such is the case in most carcasses retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In the animals that are retained and when the disease is not extensive enough to cause condemnation of the entire carcass, the disease is in most cases in the early stages. Had the animals been allowed to live for possibly only a short time longer, the disease would have progressed until all the carcass would have to be considered diseased. In others the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and endanger healthy cattle and swine.

HOW TO PROCEED TO MAKE CERTAIN THAT CATTLE AND SWINE ARE FREE FROM TUBERCULOSIS.

Have a competent veterinarian apply the tuberculin test. Remove all reactors promptly, and disinfect the premises immediately after the removal of the reacting cattle.

Do not feed any infected dairy products to swine or young cattle.

Retest the herd with tuberculin once a year.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger, State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from that farm.

TABLE 1.—*Number of cattle and swine slaughtered, and those retained and condemned on account of tuberculosis at establishments where Federal meat inspection is maintained.*

Fiscal year.	Cattle.			Swine.		
	Slaughtered.	Retained.	Condemned.	Slaughtered.	Retained.	Condemned.
1907 [1]	5,867,642	24,876	17,117	26,189,026	362,445	48,544
1908	7,116,275	68,395	24,371	35,113,077	719,279	77,554
1909	7,325,337	100,650	24,525	35,427,931	860,425	45,113
1910	7,962,189	123,501	27,638	27,656,021	792,176	28,880
1911	7,781,030	133,551	27,186	29,916,363	1,117,789	31,517
1912	7,532,005	160,122	35,273	34,966,378	1,643,100	42,267
1913	7,155,816	152,560	33,001	32,287,538	1,809,751	47,632
1914	6,724,117	143,699	29,738	33,289,705	2,201,005	48,252
1915	6,964,402	158,239	32,644	36,247,958	2,774,835	66,023
1916	7,404,288	190,991	37,085	40,482,799	3,687,817	74,109
1917	9,299,489	218,928	46,351	40,210,847	3,978,168	76,807
1918	10,938,287	222,787	40,692	35,449,247	3,494,587	59,740
1919	11,241,991	205,698	37,600	44,298,389	4,103,376	65,837
1920	9,709,819	200,647	37,492	38,981,914	4,260,719	65,609
1921	8,179,572	173,658	33,328	37,702,866	4,693,305	64,830
1922	7,871,457	213,606	39,434	39,416,439	5,640,081	70,304
1923	9,029,536	251,293	49,839	48,600,069	7,146,925	88,688

[1] Covers 9 months from October 1, 1906, to June 30, 1907.

CAUSE OF TUBERCULOSIS.

The direct and primary cause of tuberculosis is a rod-shaped germ which can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or live stock is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures, paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other inclosures which contained tuberculous animals before healthy ones are again placed in them.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose

the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuberculosis among the stock whenever the germs are present. Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED WITH TUBERCULOSIS.

The tuberculous cow is the greatest source of danger to healthy cattle, and inasmuch as it can not be determined just when that animal becomes a "spreader" of the germs, unless daily microscopic tests are made of the discharges from the body, and the milk is also examined microscopically, it is unsafe to keep it with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming into contact with affected animals than in any other

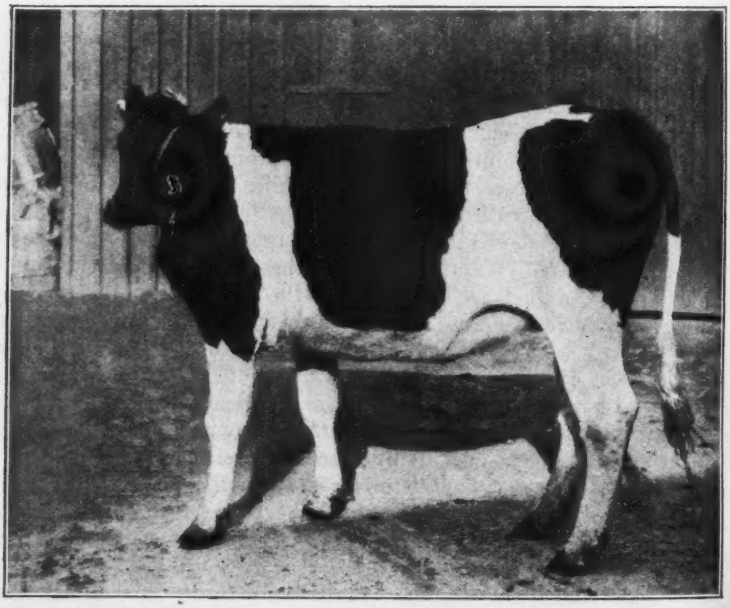

FIG. 4.—A tuberculous heifer. The gland at the shoulder was diseased and discharging tuberculous pus.

way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

The continuous water trough in barns is also accountable to a very large extent for spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which infected milk or the washings from infected milk cans have been dumped may also be a source of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected frequently by drinking milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE MAY BECOME INFECTED.

The tuberculous cow is not only a menace to other cattle but is also the commonest source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the development of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record, also, in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are kept on the same farm, some of the latter are tuberculous. Eradication of tuberculosis from cattle, it is believed, will greatly reduce its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuber-

culosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another.

SYMPTOMS OF TUBERCULOSIS.

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms. Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions

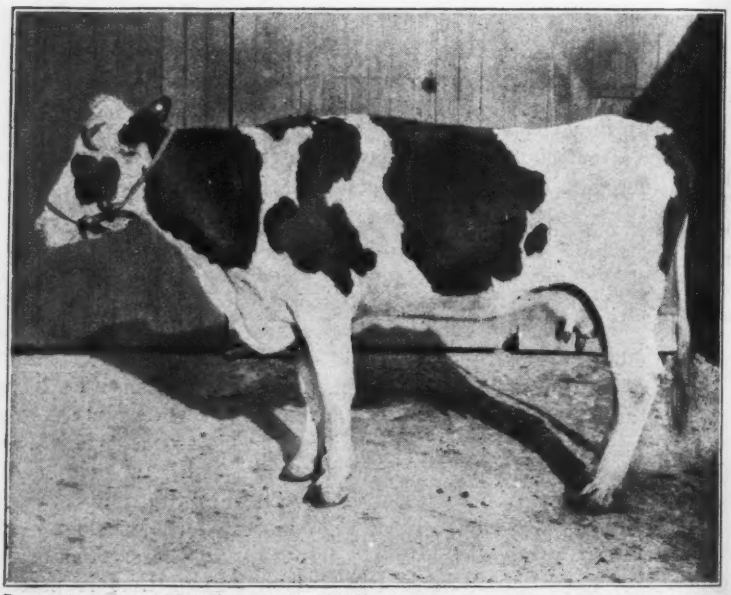

FIG. 5.—A reacting cow that was constantly "bloating." The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating.

which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body, an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands

of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening, as shown in figure 4. Animals affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an animal are affected, it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased, the animal often develops bloat (fig. 5). Diarrhea is often evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

FIG. 6.—Part of a tuberculous udder showing well-developed lesions.

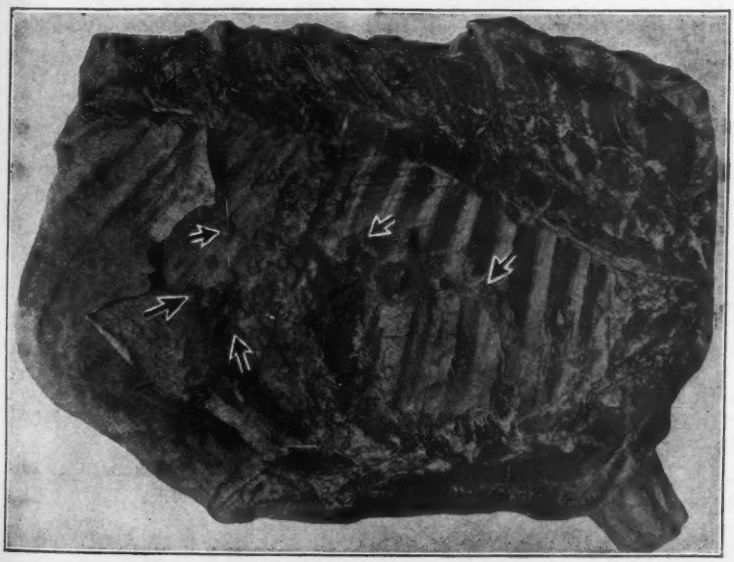

FIG. 7.—Beef carcass showing tuberculous nodules on ribs.

METHODS OF DIAGNOSIS.

Microscopic examinations of sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of experience the tuberculin test is now considered to be the most practicable and satisfactory way of discovering the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

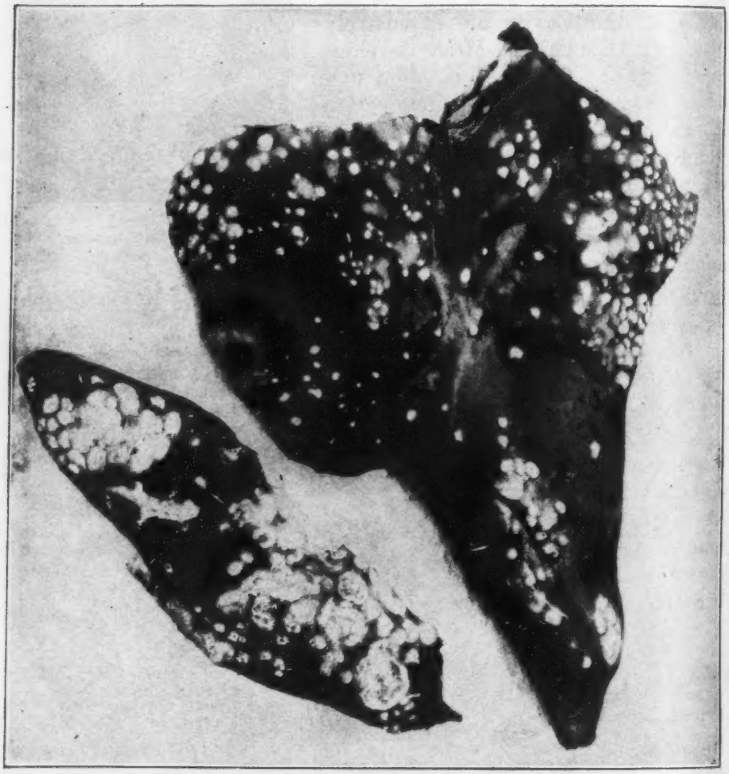

FIG. 8.—Liver and spleen showing extensive lesions of tuberculosis.

THE TUBERCULIN TEST.

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and in the hands of skillful persons, it is a reliable agent for detecting tuberculosis in animals. It contains no living tubercle bacilli but is a product of the growth of tubercle bacilli properly mixed with a substance on which it has grown and properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used.

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action. Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to its application at another time; therefore it may be misused by unscrupulous persons.

THE SUBCUTANEOUS TEST (UNDER THE SKIN).

The subcutaneous test is made by injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to measure the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are measured at least 3 times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the person applying the test, and a careful observance of any clinical changes is always important in determining the result. It can not be set forth too strongly that the test, including the two following methods, should be attempted only by those who are properly qualified to do the work.

THE INTRADERMIC TEST (INTO THE SKIN).

The intradermic test for detecting tuberculosis is used to a considerable extent because of its convenience. When made by those who have become skilled in its application, it is very accurate. In this test the tuberculin is injected between the layers of the skin, only a few drops being used, and it is usually applied in the region at

the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine, and when so used the tuberculin is applied into the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is usually observed from 72 to 120 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced person.

THE OPHTHALMIC TEST (INTO THE EYE).

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the previously described methods. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the

RELIABILITY OF THE PRINCIPAL TUBERCULIN TESTS.

The subcutaneous test is made by injecting, under the skin, a small quantity of tuberculin. Carefully and conscientiously applied, with good judgment exercised in both its administration and interpretation, it is wholly effective.

The intradermic test is especially suitable for range cattle or animals whose movements are difficult to control, and in area work. In this test the tuberculin is injected between the layers of the skin.

The ophthalmic test, or so-called "eye test," is not at present accepted for testing cattle for interstate shipment, though it has value as a check test and is recognized for that purpose. It is applied by placing the ophthalmic tuberculin in one eye, using the other as a check. The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit. In all cases the tests, used either alone or in combination, should be applied by capable persons familiar with tuberculin testing.

FIG. 9.—Part of a herd of 69 cattle, 30 per cent tuberculous in 1917, 5 per cent tuberculous in 1918, 100 per cent free from tuberculosis in 1919. The herd is now accredited.

disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from

FIG. 10.—How a herd may become reinfected with tuberculosis. This herd was free from tuberculosis for a number of years. During 1917, 4 cattle were purchased in another State and placed in the herd without proper tuberculin test. When official test was made, December, 1917, 5 reactors were found. Three of the reactors were slaughtered and 2 kept in the herd. At the next test, January, 1919, 11 reactors and 2 suspects were in the herd of 28 cattle.

the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

POST-MORTEM APPEARANCES.

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs. The lesions are of various sizes and may contain pus, either soft or hard; many times it is gritty. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities. Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands, to some extent, are usually affected, and, when cut into, show diseased areas characteristic of tuberculosis.

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible for even the most skillful person in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals reacting to the test were not affected with tuberculosis to some extent even though some were very slight.

METHODS OF ERADICATION.

Cattle owners who do not know whether tuberculosis exists among their animals should ascertain the fact by having them tuberculin-tested and physically examined by a qualified veterinarian. In many cases thousands of dollars and very valuable breeding animals might have been saved by taking up tuberculosis-eradication work in time. Three main projects comprise the general campaign of eradication, as follows:

1. Eradication of tuberculosis from pure-bred herds of cattle.
2. Eradication of tuberculosis from circumscribed areas.
3. Eradication of tuberculosis from swine.

It is important to eradicate tuberculosis from pure-bred herds of cattle at the earliest possible date because the spread of the disease is greater among such animals than among grade cattle. The reason is plain; pure-bred animals are shipped extensively to every part of the United States for breeding purposes. A pure-bred bull or cow may be shipped from Maine to Texas, or from the State of Washington to Florida. If it is diseased and is introduced into a healthy herd, it not only fails to fulfill the purpose for which it was intended—the upbreeding of the herd—but it actually causes heavy damage by spreading the disease to healthy animals.

FIG. 11.—This Hereford herd was freed from tuberculosis within 3 years. The first test, in 1916, showed the herd to be 10 per cent tuberculous. The reactors were removed and in 1918 all the 62 animals in the herd were found to be healthy.

ACCREDITED-HERD OR HONOR-ROLL PLAN.

The breeders of pure-bred registered cattle fully appreciated the above-mentioned fact when, together with the live-stock sanitary officials of practically all the States, they adopted what is known as the accredited-herd plan, the principles of which are that herds found to be free from tuberculosis on two successive annual tests are placed on the Honor Roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of one year. This plan is becoming well known to breeders throughout the United States. The progress of the accredited-herd plan is given in Table 2.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for pure breds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly

tuberculin tested. To make a satisfactory test all the cattle should be in normal condition and, so far as practicable, the cattle should be stabled under usual conditions and among usual surroundings. Feeding and watering should be conducted in the customary manner, with the exception that feed and water should be given only after the temperature has been taken. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

TABLE 2.—*Status of cooperative tuberculosis-eradication work, including all herds under supervision, July, 1923.*

State.	Total once-tested free.		Total accredited.		Total under supervision.	
	Herds.	Cattle.	Herds.	Cattle.	Herds.	Cattle.
Alabama	845	18,653	125	5,251	963	24,016
Arizona	489	13,307	0	0	666	14,260
Arkansas	167	984	45	1,440	227	2,599
California	1,739	81,391	7	155	2,023	113,475
Colorado	79	1,876	4	221	105	3,020
Connecticut	954	17,502	267	5,582	1,221	25,177
Delaware	1,108	4,483	553	2,572	2,331	11,517
District of Columbia	313	342	30	797	345	1,166
Florida	4,052	30,822	192	6,866	4,982	57,398
Georgia	2,666	41,714	43	3,152	3,040	59,553
Idaho	8,973	86,611	139	4,332	10,669	114,988
Illinois	971	19,238	454	10,258	12,223	109,366
Indiana	16,726	120,908	3,692	53,082	22,985	197,827
Iowa	5,544	86,363	2,187	55,215	10,454	211,518
Kansas	463	13,642	687	20,440	1,323	40,208
Kentucky	15,524	94,554	237	6,761	18,138	136,320
Louisiana	1,058	19,338	120	5,984	266	35,480
Maine	12,349	99,782	1,554	16,115	13,902	112,637
Maryland	2,689	24,296	513	10,171	4,961	47,979
Massachusetts	210	3,576	91	3,422	334	8,609
Michigan	28,582	209,626	477	9,870	34,066	283,919
Minnesota	2,431	38,126	2,763	58,905	6,074	119,670
Mississippi	396	12,475	161	4,485	719	17,645
Missouri	36,696	344,137	555	19,261	38,307	386,065
Montana	14,000	197,889	136	8,078	14,852	264,959
Nebraska	11,858	142,332	387	13,464	14,035	192,900
Nevada	1,680	11,487	13	1,282	1,674	11,766
New Hampshire	1,509	13,109	245	5,193	2,234	28,309
New Jersey	267	2,193	154	3,213	724	11,399
New Mexico	1,506	12,123	2	65	1,710	13,392
New York	11,624	135,520	1,489	29,721	15,815	460,073
North Carolina	85,394	192,435	59	2,695	69,828	216,947
North Dakota	6,133	100,433	1,405	31,836	9,144	172,181
Ohio	2,968	34,313	1,062	19,425	4,603	65,595
Oklahoma	221	7,087	373	11,744	692	24,115
Oregon	14,500	127,381	232	5,783	14,732	133,164
Pennsylvania	6,249	61,423	2,0 4	33,634	10,643	121,620
Rhode Island	17	339	17	427	53	1,508
South Carolina	900	11,195	129	4,365	3,438	23,536
South Dakota	317	10,589	276	7,426	688	21,985
Tennessee	583	13,447	296	10,348	10,969	94,728
Texas	162	4,452	127	7,945	433	24,285
Utah	7,393	34,079	99	3,014	8,201	56,527
Vermont	1,276	21,613	1,836	32,613	5,069	81,393
Virginia	1,107	14,925	992	21,882	2,403	45,195
Washington	15,668	117,825	137	4,440	16,201	127,296
West Virginia	3,929	25,806	374	7,896	3,687	44,400
Wisconsin	3,745	70,225	3,204	72,042	7,533	172,991
Wyoming	4,263	50,392	8	557	4,854	58,644
Total	342,273	2,796,348	29,982	643,425	414,539	4,603,315

FIG. 12.—An accredited Jersey herd, Minnesota.

PRINCIPAL BENEFITS OF COMPLETE ERADICATION OF TUBERCULOSIS.

Increased value of individual animal and increased herd value.

Ability to ship interstate from accredited herds without further testing for a period of one year.

The owner's name being listed in pamphlets published by the respective States and the Bureau of Animal Industry.

Confidence by those who desire to purchase cattle to add to their herds.

Satisfaction of knowing that the dairy products offered for sale are free from diseased germs.

Elimination of economic losses caused by the disease.

ERADICATION FROM AREAS.

The unit territory to be worked will depend mainly upon the extent to which the disease has spread. In some States practically every county contains numerous tuberculous herds, so that, to control the disease effectively, all the herds must be tuberculin tested. In other States, however, the disease is confined to the beef and dairy herds recently established or to which new animals have lately been added. In the latter case it would not be necessary to test all the cattle, but the examination of the herds should be sufficient to demonstrate most satisfactorily that no diseased herds are overlooked. This can be done by testing several herds in each section of the county wherever there is a suspicion that the disease may exist.

As a general plan, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county should pay (1) part of the expense of exterminating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it is advisable to clean up the herds within a township or possibly one-third or one-half of the area. The progress depends upon the degree of infection found and the cooperation furnished by the owners.

FIG. 13.—An accredited Guernsey herd, Wisconsin.

FIG. 14.—An accredited Ayrshire herd, West Virginia.

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin tested; of the total number, 321 cattle, or 18.87 per cent, were tuberculous. The reactors were removed from the herds and, in most instances, were slaughtered. The infected barns, sheds, and premises were cleaned and disinfected.

Each year since the inauguration of the campaign all the cattle have been tuberculin tested with the result that the infection has almost disappeared.

There are States in which tuberculosis exists to less than 1 per cent among all the bovine population. The plan of carrying on eradication in several counties at the same time in those States is practicable and is being conducted in a number of States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make, it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The larger herds, especially around cities and those supplying milk locally and for shipment to other cities, should be tested before the small lots. If it is known that the herds are but slightly infected, the intradermic method should be employed, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermic test, the entire herd should be tested subcutaneously within a short time. The ophthalmic test may also be used in conjunction with the subcutaneous in "check" testing

FIG. 15.—An accredited herd of pure-bred Milking Shorthorns, Virginia.

herds. General experience shows that it is sound practice, if there is any doubt, to use all three methods of testing with tuberculin. Such a policy is especially applicable to cattle which have been tested frequently, and among herds which are or have been extensively diseased.

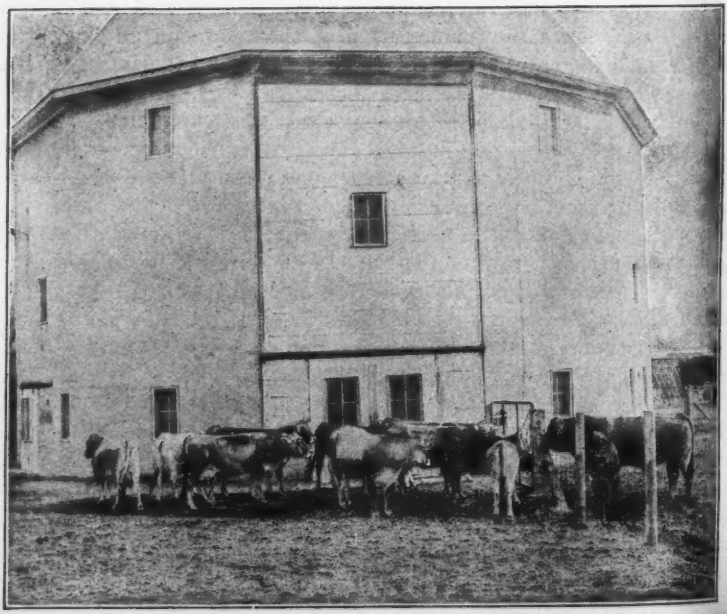

FIG. 16.—An accredited Brown Swiss herd, Indiana.

ERADICATION FROM SWINE.

With the gradual elimination of tuberculosis from cattle, the disease among swine will grow correspondingly smaller. It is not necessary to tuberculin test all the swine herds because, with the exception of valuable breeding animals, it is more economical to slaughter the diseased ones when fat than to undertake to exterminate the disease in any other way.

In the case of suspected, valuable pure-bred swine, their freedom from tuberculosis can be determined definitely by the intradermic method, which is practicable and reliable.

The injection is near the base of the left ear; the other ear acts as a check for comparison. A reaction is manifested by a swelling in the

FIG. 17.—An accredited Red Poll herd, Virginia.

region where the tuberculin was injected. The swelling may appear any time from the 24th to the 104th hour after injection and will remain for several days. As in the case of cattle, diseased swine should be removed from the farm, and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

MEASURES OF PREVENTION.

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regu-

lating the movements of cattle, and recently, with that object in view, action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the live-stock owner. It is he who must take a very important part all through the campaign of tuberculosis eradication, and if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped

FIG. 18.—An accredited Aberdeen-Angus herd, Minnesota.

whenever possible. After diseased animals are found and removed from the premises, a *very thorough* cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant. The use of disinfectants without first doing the necessary and proper cleaning is ineffective for the reason that the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences can then be sprayed properly with the disinfectant.

FIG. 19.—An accredited Shorthorn herd, North Dakota.

All this means much work but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where live stock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

FIG. 20.—An accredited Hereford herd, Kentucky.

DISPOSAL OF REACTORS.

The disposal of reactors depends largely upon the State laws and live-stock regulations of the State in which the herd belongs. If the animals are pure bred and registered and of unusual merit, they should be segregated, preferably on farms set aside by the State or by the pure-bred cattle associations, for the purpose of retaining tuberculous cattle in quarantine. If the condemned animals are

FIG. 21.—An accredited Polled Durham herd, Minnesota.

THE ACCREDITED-HERD PLAN—EVERY CATTLE OWNER ELIGIBLE.

A tuberculosis-free accredited herd is one which has been tuberculin tested by the subcutaneous method or any other approved method under the supervision of the Bureau of Animal Industry, or of a regularly employed veterinary inspector of the State in which cooperative tuberculosis eradication is being conducted.

It is a herd in which no animal affected with tuberculosis has been found upon two annual or three semiannual tests, made as described, and by physical examination.

Owners of tuberculosis-free herds receive a certificate issued by the bureau and the State live-stock sanitary authorities. The certificate is good for one year from the date of the test, unless revoked at an earlier date.

grade cattle, or pure breds not specially valuable for breeding, it will probably be more economical to have them slaughtered than to hold them in quarantine. Of course the fact is recognized that in States and communities where tuberculosis exists extensively the slaughtering of all reactors is impracticable. In such instances the infection can be reduced on all the farms by keeping the tuberculous animals separate from the healthy ones. The tuberculous cattle are kept under quarantine restrictions until no longer profitable; meanwhile the healthy animals are safe from the danger of infection.

RETESTING.

It is rather uncommon for tuberculosis to be eradicated from an infected herd after one tuberculin test. After the removal of reactors the herd should be retested at the expiration of six months, and a second retest may be advisable six months later, but the practice of testing herds more frequently than that is not usually advised. After two or three semiannual tests the herd should not be tested oftener than every 12 months. While the subcutaneous test is considered preferable for gentle cattle, the ophthalmic and intradermic methods of testing may be employed to advantage as adjuncts to it; and it is believed that in some instances herds may be freed of tuberculosis earlier by the judicious use of all three methods. No general outline can be given as to when all three tests should be employed; the matter should be left to the judgment of the veterinarian under whose direction the work is carried on.

MARKING ANIMALS FOR IDENTIFICATION.

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified as affected with tuberculosis. One method that is quite generally used is that of branding; a letter "T" about 2 inches high is branded on the lower jaw, or sometimes it is placed on other parts of the body where it can be seen readily. In addition to the branding it is advisable to tag the reacting animals so that one may be identified from another, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is usually placed in the ear of the animal and contains a serial number as well as the word "Reactor."

Another method that is sometimes used is the punching of a letter "T" out of the ear, and it has been quite satisfactory.

The marking of cattle that have passed the tuberculin test is a matter that is being handled in different ways throughout the United States, and it is believed that the present methods of marking will be improved. In some cases a metal ear tag is used and in others certain marks of identification are tattooed in the ear. Tattooing

has an advantage over the tagging in that it is less expensive and probably more permanent.

It is not often necessary to require special marks on pure-bred registered cattle, as the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking that will show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine so that the origin of those found to be tuberculous on post-mortem examination can be learned would be very desirable, and some experimental work along this line is now being conducted by the bureau in cooperation with owners and packers. The results so far obtained indicate that the tattooing of a number or some mark of identification into the skin of the hog is the most practicable method but of course it entails additional labor and expense which would amount to a great deal if carried on throughout the country. It is hoped a more practicable and economical means of marking swine for identification will be developed in the future, as much good in the campaign for the eradication of tuberculosis in live stock can be accomplished in that way.

Many shipments which contain tuberculous swine are traced back to the farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised, efforts can be directed in eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY.

In addition to the various benefits derived from eradicating tuberculosis, provision for the appraisement of diseased cattle with indemnity for those slaughtered is a further incentive. Federal legislation and supplementary laws in numerous States now divide the burden

WHY THE TUBERCULIN TEST IS HARMLESS.

Tuberculin contains only the sterilized products of the tubercle bacilli. It does not contain any living germ; therefore it is harmless to any animal whether healthy or diseased.

Only diseased animals give typical reactions to the test. The test does not injure animals in a condition of advanced pregnancy, and will not cause them to react if they are free from disease.

Likewise, it does not produce reactions in disease-free animals which have recently calved.

HOW THE WORK OF ERADICATION IS DIVIDED BETWEEN STATE AND GOVERNMENT OFFICIALS AND OTHERS.

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the U. S. Department of Agriculture, the live-stock sanitary officials of the various States, and individual cattle owners. The bureau and the State officials send veterinary inspectors to apply tuberculin tests to the herds of those owners who sign a cooperative agreement, which places their herds jointly under supervision for the control and eradication of the disease.

of loss, so that the Government, the State, and the owner of the cattle all bear a share of it. Briefly, the Federal law provides that the Secretary of Agriculture may reimburse partly owners of animals destroyed on account of tuberculosis in cooperation with States, counties, and municipalities. The bases upon which Federal indemnities are paid are:

1. No payment shall exceed one-third of the difference between the appraised value of such animal and the salvage value.
2. No payment shall exceed the amount paid or to be paid by the State, county, or municipality.
3. In no case shall any payment be more than $25 for any grade animal or more than $50 for any pure-bred animal.
4. No payment shall be made unless the owner has complied with all lawful quarantine regulations.

Legislation regarding indemnities for tuberculous cattle varies somewhat in different States and, for detailed and current information on the subject, the reader is referred to his State live-stock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained by addressing the Bureau of Animal Industry U. S. Department of Agriculture.

A careful study of figures 4, 6, 7, and 8 in this bulletin will enable the reader to become familiar with the appearance of the parts of the body most commonly affected. He will also see, even more clearly than can be described, that a real danger exists in permitting diseased animals or those of doubtful health to mingle with others. The illustrations of the accredited herds, on the other hand, show the splendid types of cattle which their owners have subjected to the tuberculin test and which have passed it successfully.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

October 1, 1923.

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This bulletin is a contribution from

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1069 rev. Apr. 1924

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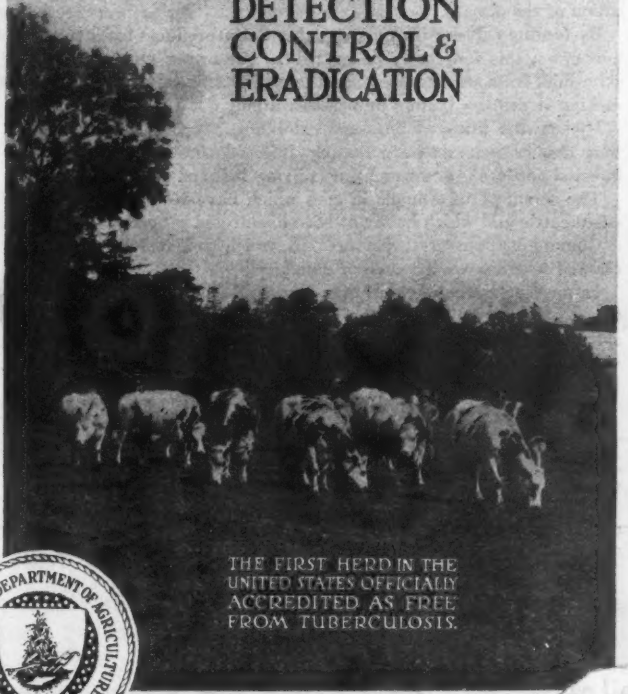
TUBERCULOSIS IN LIVE STOCK

DETECTION CONTROL & ERADICATION



THE FIRST HERD IN THE UNITED STATES OFFICIALLY ACCREDITED AS FREE FROM TUBERCULOSIS.

XUM

HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE.

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

By the addition of an animal that is affected with the disease; therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

By feeding calves with milk or other dairy products from tuberculous cows; this frequently occurs where the owner purchases mixed skim milk from the creamery, and feeds it to his calves without first making it safe by boiling or pasteurization.

By showing cattle at fairs and exhibitions; reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

The shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

Community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

Washington, D. C.

Issued November, 1919
Revised April, 1924

TUBERCULOSIS IN LIVE STOCK.

DETECTION, CONTROL, AND ERADICATION.

JOHN A. KIERNAN, *Chief*, and ALEXANDER E. WIGHT, *Assistant Chief, Tuberculosis Eradication Division, Bureau of Animal Industry.*

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PRESENT KNOWLEDGE OF TUBERCULOSIS.

PROBABLY no disease affecting either the human race or live stock is better known or has been the object of so much study as tuberculosis. Present knowledge of the disease is derived from many sources, including the work of eminent scientists who discovered its cause, and studies of the numerous ways in which it is spread, of the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1882 by the eminent scientist, Dr. Robert Koch. Thus the test has been known for more than a third of a century. The facts regarding it and other information presented in this bulletin are based upon long experience and results verified many times. The methods recommended to be used in the eradication of tuberculosis have been tried upon large numbers of herds and found to be effectual and practicable.

EARLY ERADICATION IS MOST ECONOMICAL.

Live-stock owners are earnestly requested not to wait until the States and Federal Government come into their localities to eradicate tuberculosis. It would not be possible indeed, at this stage to undertake to eradicate tuberculosis from the live stock of the United States solely through organized official forces established by the respective States and the Federal Government. The area over which tuberculosis has spread is too vast, the herds too numerous, and

funds are insufficient for conducting the work on so extensive a plan even though trained veterinarians were available in sufficient numbers to do the work. Every live-stock owner should be a party to this campaign which has been inaugurated to eradicate tuberculosis. In almost every locality of the United States are veterinarians capable of rendering valuable services to live-stock owners in this great work, and the cost of eradicating is greatly reduced by combating the disease in its early stages. Yet even in badly affected herds eradication can be undertaken with success. There are records of many herds, in which three-fourths of the animals

FIG. 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. Upon application of the tuberculin test, 37, or 82 per cent, of the animals were found to be tuberculous. The germs of the disease may live for months in manure or litter.

were affected with tuberculosis, which eventually were freed from it and afterwards maintained in a healthy condition.

The extirpation of tuberculosis from live stock is important not only from an economic standpoint, but also because a considerable percentage of tuberculosis in the human family, especially among children, is positively due to the consumption of infected milk or other dairy products from tuberculous cows. It is eminently proper for the respective State governments to expend funds for the maintenance of tuberculosis sanitariums for the care of persons afflicted with that disease, and likewise it is extremely important to use vigorous measures to check the marketing of germ-laden milk. While it is true that proper pasteurization of milk destroys the living organisms

of tuberculosis, a large part of the milk consumed daily is not pasteurized, and some of the milk so treated is not always made entirely safe.

TUBERCULOSIS A DECEPTIVE DISEASE.

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among the live-stock owners, who would insist upon its immediate eradication; but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals, many people believe that it does comparatively little damage among live stock. Contrary to such opinions, however, the loss from tuberculosis is one of the heaviest taxes imposed upon our live-stock industry, amounting, probably, to at least $40,000,000 a year in the United States.

PREVALENCE OF TUBERCULOSIS.

In every State and Territory in the Union there is some tuberculosis among cattle and swine, though the degree varies considerably. In some States it probably exists quite extensively, the percentage varying from 5 to 30 per cent of the cattle population, while in certain others investigations indicate that less than 1 per cent of the total of beef and dairy cattle are tuberculous.

Tuberculosis is known to exist also quite extensively among cattle and swine in all the European countries; in fact, no part of the world is known to be free from it absolutely. There are, however, some restricted regions where its presence is not known, or it exists to but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States, tuberculosis among live stock in those regions was unknown so far as we know. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but live-stock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the live-stock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

In some localities in the West, where dairying has developed extensively, it is now known that carload lots of cows purchased in other States have contained 50 per cent or more of tuberculous animals. Some herds of beef cattle in our western country have become contaminated with the disease by placing among them tuberculous pure-bred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is to-day. Consequently in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick. Therefore there is probably less tuberculosis among the herds of the Southern States than in any other part of the Nation. This favorable condition should be taken advantage of, for in all probability the live-stock industry will reach a high development in that area in future years. It is especially important that the herds of the Southern States be protected by permitting only tuberculosis-free animals to enter.

FIG. 2.—An insanitary barn. Nearly all the cows kept in it were tuberculous. The stone foundation wall retains about 2 feet of liquid manure which contains millions of tubercle germs. Premises of this character can not be kept sanitary.

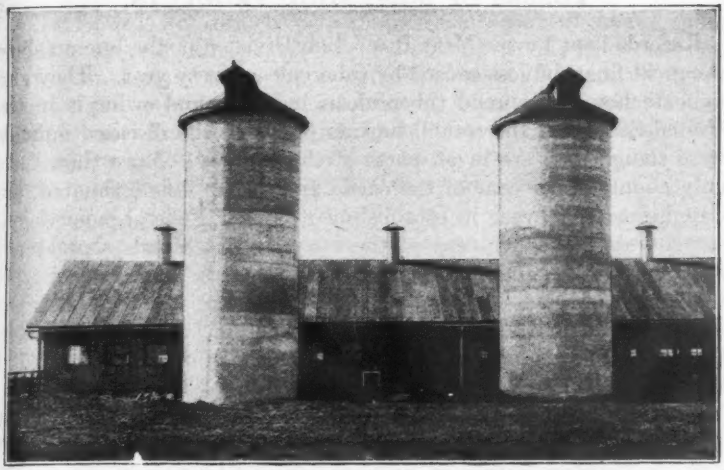

FIG. 3.—A modern sanitary barn. Note ventilators and liberal window space.

HOW THE DISEASE SPREADS IN A HERD.

The tuberculous cow is the greatest source of danger to healthy cattle. Any reacting cattle not promptly removed from the herd constitute a source of constant infection.

Tuberculous cattle, sooner or later, begin to give off the germs of the disease. These germs escape by the mouth, nose, and bowels, in the milk, and other discharges. The discharged germs are carried in the air for a time until they fall to the ground.

Animals in adjoining stalls may take in the germs in the feed they eat and thus contract the disease. Continuous water troughs in barns containing diseased cattle are a source of danger. Drinking holes containing material from infected animals are likewise dangerous.

Failure to clean and disinfect the premises occupied by the diseased cattle constitutes another source of danger. Infected milking tubes and the practice of feeding calves with raw milk from tuberculous cows are other means by which tuberculosis spreads in a herd.

LOSSES OF MEAT FOOD PRODUCTS.

Records kept by the Meat Inspection Division of the bureau show the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 per cent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 per cent of these classes of animals slaughtered each year in the United States do not appear in these records. It is known also that the percentage of tuberculosis is greater in the uninspected animals. In view of these points the losses shown in the following table are believed to be scarcely one-half of the total loss throughout the country.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is placed aside for further examination. If the disease is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed and the remainder is passed. It will be noted that such is the case in most carcasses retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In the animals that are retained and when the disease is not extensive enough to cause condemnation of the entire carcass, the disease is in most cases in the early stages. Had the animals been allowed to live for possibly only a short time longer, the disease would have progressed until all the carcass would have to be considered diseased. In others the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and endanger healthy cattle and swine.

HOW TO PROCEED TO MAKE CERTAIN THAT CATTLE AND SWINE ARE FREE FROM TUBERCULOSIS.

Have a competent veterinarian apply the tuberculin test. Remove all reactors promptly, and disinfect the premises immediately after the removal of the reacting cattle.

Do not feed any infected dairy products to swine or young cattle.

Retest the herd with tuberculin once a year.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger, State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from that farm.

TABLE 1.—*Number of cattle and swine slaughtered, and those retained and condemned on account of tuberculosis at establishments where Federal meat inspection is maintained.*

Fiscal year.	Cattle.			Swine.		
	Slaughtered.	Retained.[1]	Condemned.	Slaughtered.	Retained.[1]	Condemned.
1907[2]	5,867,642	24,876	17,117	26,189,026	362,445	48,544
1908	7,116,275	68,395	24,371	35,113,077	719,279	77,554
1909	7,325,337	100,650	24,525	35,427,931	860,425	45,113
1910	7,962,189	123,501	27,638	27,656,021	792,176	28,880
1911	7,781,030	133,551	27,186	29,916,363	1,117,789	31,517
1912	7,532,005	160,122	35,273	34,966,378	1,643,100	42,267
1913	7,155,816	152,560	33,001	32,287,538	1,809,751	47,632
1914	6,724,117	143,699	29,738	33,289,705	2,201,005	48,252
1915	6,964,402	158,239	32,644	36,247,958	2,774,835	66,023
1916	7,404,288	190,991	37,085	40,482,799	3,687,817	74,109
1917	9,299,489	218,928	46,351	40,210,847	3,978,168	76,807
1918	10,938,287	222,787	40,692	35,449,247	3,494,587	59,740
1919	11,241,991	205,698	37,600	44,298,389	4,103,376	65,837
1920	9,709,819	200,647	37,492	38,981,914	4,260,719	65,609
1921	8,179,572	173,658	33,328	37,702,866	4,693,305	64,830
1922	7,871,457	213,606	39,434	39,416,439	5,640,081	70,304
1923	9,029,536	251,299	49,839	48,600,069	7,139,925	88,688

[1] Held for more complete examination to determine final disposal.
[2] Covers 9 months from Oct. 1, 1906, to June 30, 1907.

CAUSE OF TUBERCULOSIS.

The direct and primary cause of tuberculosis is a rod-shaped germ which can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or live stock is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures, paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other inclosures which contained tuberculous animals before healthy ones are again placed in them.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose

the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuberculosis among the stock whenever the germs are present. Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED WITH TUBERCULOSIS.

The tuberculous cow is the greatest source of danger to healthy cattle, and inasmuch as it can not be determined just when that animal becomes a "spreader" of the germs, unless daily microscopic tests are made of the discharges from the body, and the milk is also examined microscopically, it is unsafe to keep it with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming into contact with affected animals than in any other

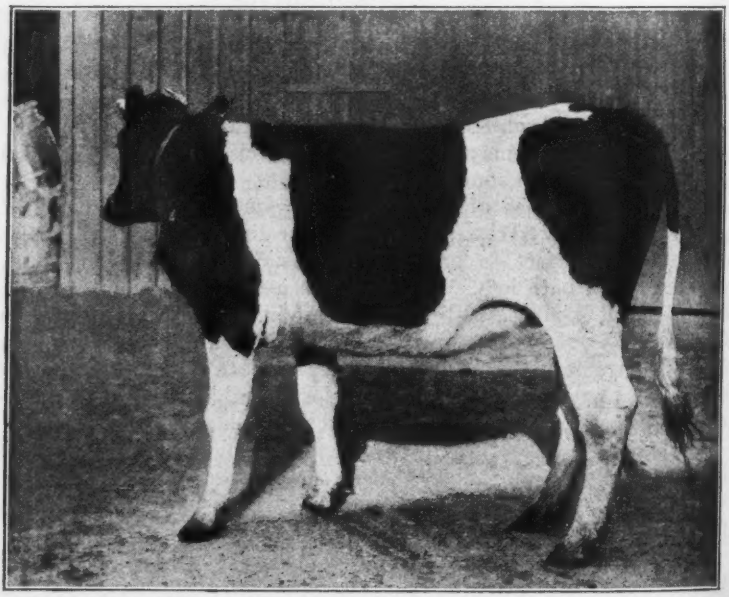

FIG. 4.—A tuberculous heifer. The gland at the shoulder was diseased and discharging tuberculous pus.

way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

The continuous water trough in barns is also accountable to a very large extent for spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which infected milk or the washings from infected milk cans have been dumped may also be a source of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected frequently by drinking milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE MAY BECOME INFECTED.

The tuberculous cow is not only a menace to other cattle but is also the commonest source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the development of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record, also, in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are kept on the same farm, some of the latter are tuberculous. Eradication of tuberculosis from cattle, it is believed, will greatly reduce its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuber-

culosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another.

SYMPTOMS OF TUBERCULOSIS.

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms. Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions

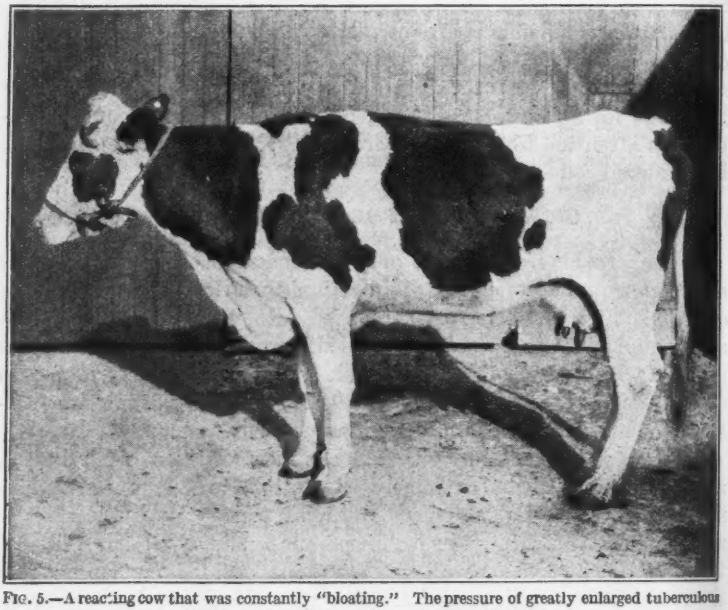

FIG. 5.—A reacting cow that was constantly "bloating." The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating.

which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body, an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands

of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening, as shown in figure 4. Animals affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an animal are affected, it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased, the animal often develops bloat (fig. 5). Diarrhea is often evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

FIG. 6.—Part of a tuberculous udder showing well-developed lesions.

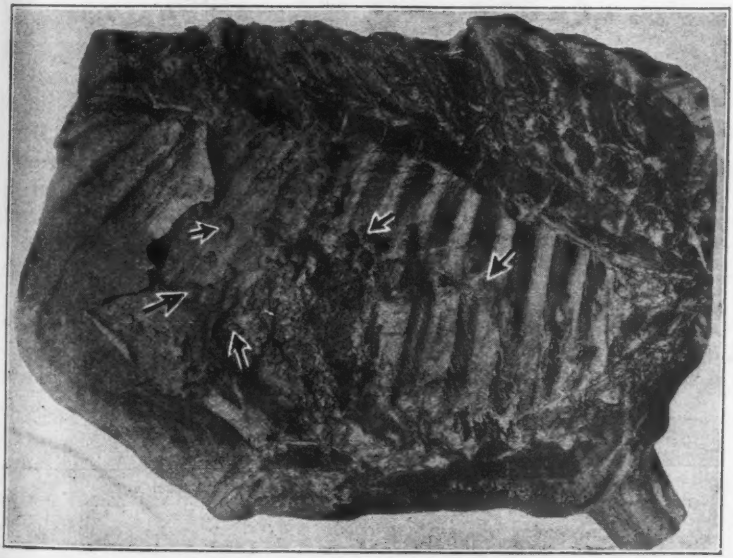

FIG. 7.—Beef carcass showing tuberculous nodules on ribs.

METHODS OF DIAGNOSIS.

Microscopic examinations of sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of experience the tuberculin test is now considered to be the most practicable and satisfactory way of discovering the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

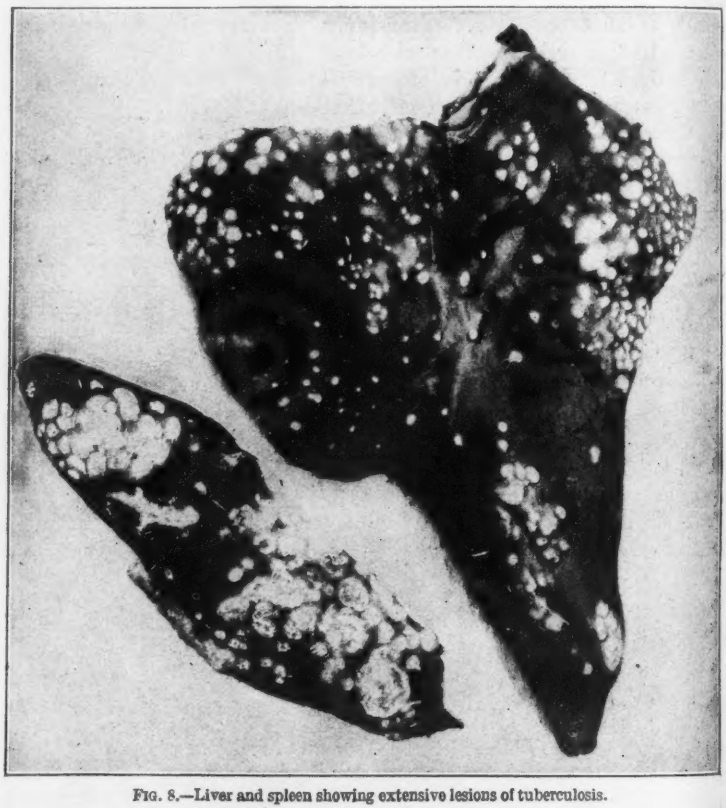

FIG. 8.—Liver and spleen showing extensive lesions of tuberculosis.

THE TUBERCULIN TEST.

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and in the hands of skillful persons, it is a reliable agent for detecting tuberculosis in animals. It contains no living tubercle bacilli but is a product of the growth of tubercle bacilli properly mixed with a substance on which it has grown and properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used.

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action. Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to its application at another time; therefore it may be misused by unscrupulous persons.

THE SUBCUTANEOUS TEST (UNDER THE SKIN).

The subcutaneous test is made by injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to measure the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are measured at least 3 times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the person applying the test, and a careful observance of any clinical changes is always important in determining the result. It can not be set forth too strongly that the test, including the two following methods, should be attempted only by those who are properly qualified to do the work.

THE INTRADERMIC TEST (INTO THE SKIN).

The intradermic test for detecting tuberculosis is used to a considerable extent because of its convenience. When made by those who have become skilled in its application, it is very accurate. In this test the tuberculin is injected between the layers of the skin, only a few drops being used, and it is usually applied in the region at

the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine, and when so used the tuberculin is applied into the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is usually observed from 72 to 120 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced person.

THE OPHTHALMIC TEST (INTO THE EYE).

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the previously described methods. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the

RELIABILITY OF THE PRINCIPAL TUBERCULIN TESTS.

The subcutaneous test is made by injecting, under the skin, a small quantity of tuberculin. Carefully and conscientiously applied, with good judgment exercised in both its administration and interpretation, it is wholly effective.

The intradermic test is especially suitable for range cattle or animals whose movements are difficult to control, and in area work. In this test the tuberculin is injected between the layers of the skin.

The ophthalmic test, or so-called "eye test," is not at present accepted for testing cattle for interstate shipment, though it has value as a check test and is recognized for that purpose. It is applied by placing the ophthalmic tuberculin in one eye, using the other as a check. The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit. In all cases the tests, used either alone or in combination, should be applied by capable persons familiar with tuberculin testing.

FIG. 9.—Part of a herd of 69 cattle, 30 per cent tuberculous in 1917, 5 per cent tuberculous in 1918, 100 per cent free from tuberculosis in 1919. The herd is now accredited.

disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from

FIG. 10.—How a herd may become reinfected with tuberculosis. This herd was free from tuberculosis for a number of years. During 1917, 4 cattle were purchased in another State and placed in the herd without proper tuberculin test. When official test was made, December, 1917, 5 reactors were found. Three of the reactors were slaughtered and 2 kept in the herd. At the next test, January, 1919, 11 reactors and 2 suspects were in the herd of 28 cattle.

the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

POST-MORTEM APPEARANCES.

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs. The lesions are of various sizes and may contain pus, either soft or hard; many times it is gritty. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities. Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands, to some extent, are usually affected, and, when cut into, show diseased areas characteristic of tuberculosis.

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible for even the most skillful person in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals reacting to the test were not affected with tuberculosis to some extent even though some were very slight.

METHODS OF ERADICATION.

Cattle owners who do not know whether tuberculosis exists among their animals should ascertain the fact by having them tuberculin-tested and physically examined by a qualified veterinarian. In many cases thousands of dollars and very valuable breeding animals might have been saved by taking up tuberculosis-eradication work in time. Three main projects comprise the general campaign of eradication, as follows:

1. Eradication of tuberculosis from pure-bred herds of cattle.
2. Eradication of tuberculosis from circumscribed areas.
3. Eradication of tuberculosis from swine.

It is important to eradicate tuberculosis from pure-bred herds of cattle at the earliest possible date because the spread of the disease is greater among such animals than among grade cattle. The reason is plain; pure-bred animals are shipped extensively to every part of the United States for breeding purposes. A pure-bred bull or cow may be shipped from Maine to Texas, or from the State of Washington to Florida. If it is diseased and is introduced into a healthy herd, it not only fails to fulfill the purpose for which it was intended—the upbreeding of the herd—but it actually causes heavy damage by spreading the disease to healthy animals.

FIG. 11.—This Hereford herd was freed from tuberculosis within 3 years. The first test, in 1916, showed the herd to be 10 per cent tuberculous. The reactors were removed and in 1918 all the 62 animals in the herd were found to be healthy.

ACCREDITED-HERD OR HONOR-ROLL PLAN.

The breeders of pure-bred registered cattle fully appreciated the above-mentioned fact when, together with the live-stock sanitary officials of practically all the States, they adopted what is known as the accredited-herd plan, the principles of which are that herds found to be free from tuberculosis on two successive annual tests are placed on the Honor Roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of one year. This plan is becoming well known to breeders throughout the United States. The progress of the accredited-herd plan is given in Table 2.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for pure breds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly

tuberculin tested. To make a satisfactory test all the cattle should be in normal condition and, so far as practicable, the cattle should be stabled under usual conditions and among usual surroundings. Feeding and watering should be conducted in the customary manner, with the exception that feed and water should be given only after the temperature has been taken. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

TABLE 2.—*Status of cooperative tuberculosis-eradication work, including all herds under supervision, February 1, 1924.*

State.	Passed one test.		Accredited.		Under supervision.	
	Herds.	Cattle.	Herds.	Cattle.	Herds.	Cattle.
Alabama	1,218	7,412	166	7,518	1,836	30,681
Arizona	1,531	26,926	2	173	1,890	28,609
Arkansas	566	4,426	45	1,440	650	7,055
California	2,002	95,848	25	1,425	2,171	122,547
Colorado	757	6,611	10	362	894	10,247
Connecticut	1,221	22,329	373	7,959	1,619	32,977
Delaware	1,218	4,759	689	3,032	2,468	12,149
District of Columbia	270	654	10	341	288	1,115
Florida	4,658	34,564	246	9,340	5,598	64,183
Georgia	3,019	50,643	40	3,134	3,700	71,621
Idaho	11,705	109,525	118	4,003	13,531	138,379
Illinois	1,390	29,880	560	13,235	56,963	254,789
Indiana	21,804	158,626	4,464	64,369	27,022	246,884
Iowa	11,262	167,280	3,041	74,361	22,898	427,055
Kansas	2,330	29,227	855	25,038	8,313	105,943
Kentucky	19,286	118,477	259	7,452	22,626	172,763
Louisiana	1,462	13,652	110	4,629	1,990	21,814
Maine	15,441	123,008	1,335	14,208	18,097	147,298
Maryland	1,641	20,114	945	18,960	5,459	52,722
Massachusetts	376	5,285	118	3,874	827	18,081
Michigan	37,973	279,758	343	7,649	44,860	371,632
Minnesota	6,375	121,944	3,439	74,630	11,834	243,690
Mississippi	437	14,018	141	4,505	730	18,574
Missouri	42,002	397,959	671	23,626	43,640	440,444
Montana	15,720	222,099	142	8,741	16,531	288,094
Nebraska	1,569	24,960	329	12,539	1,851	35,562
Nevada	1,724	14,342	15	2,364	1,729	17,937
New Hampshire	1,860	16,712	401	7,539	2,652	32,688
New Jersey	449	3,622	211	3,572	1,002	12,091
New Mexico	1,730	13,952	3	83	1,937	15,224
New York	19,844	199,907	2,406	40,210	23,749	550,000
North Carolina	82,305	233,515	52	2,601	89,963	265,605
North Dakota	8,804	141,360	1,911	41,204	12,465	225,526
Ohio	9,965	72,595	1,367	24,961	12,756	112,928
Oklahoma	231	7,033	374	11,266	686	22,546
Oregon	19,134	153,541	351	3,659	19,485	157,200
Pennsylvania	14,060	115,244	2,353	38,829	18,552	179,517
Rhode Island	29	782	18	447	54	1,517
South Carolina	710	6,874	149	4,909	3,789	21,418
South Dakota	342	11,209	304	9,101	711	22,931
Tennessee	124	4,346	345	12,267	12,666	96,018
Texas	210	5,442	151	9,297	472	24,539
Utah	7,910	40,030	100	3,044	8,737	62,844
Vermont	947	17,433	2,306	40,736	5,258	83,440
Virginia	875	12,202	1,137	26,582	2,259	46,997
Washington	20,261	165,928	137	4,423	21,392	186,153
West Virginia	4,218	28,375	439	4,433	4,042	49,735
Wisconsin	30,845	405,527	4,375	96,386	37,900	538,217
Wyoming	4,474	52,904	8	525	5,066	60,261
Total	438,284	3,812,859	37,389	784,975	605,638	6,150,549

FIG. 12.—An accredited Jersey herd, Minnesota.

PRINCIPAL BENEFITS OF COMPLETE ERADICATION OF TUBERCULOSIS.

Increased value of individual animal and increased herd value.

Ability to ship interstate from accredited herds without further testing for a period of one year.

The owner's name being listed in pamphlets published by various States and live-stock associations.

Confidence by those who desire to purchase cattle to add to their herds.

Satisfaction of knowing that the dairy products offered for sale are free from diseased germs.

Elimination of economic losses caused by the disease.

ERADICATION FROM AREAS.

The unit territory to be worked will depend mainly upon the extent to which the disease has spread. In some States practically every county contains numerous tuberculous herds, so that, to control the disease effectively, all the herds must be tuberculin tested. In other States, however, the disease is confined to the beef and dairy herds recently established or to which new animals have lately been added. In the latter case it would not be necessary to test all the cattle, but the examination of the herds should be sufficient to demonstrate most satisfactorily that no diseased herds are overlooked. This can be done by testing several herds in each section of the county wherever there is a suspicion that the disease may exist.

As a general plan, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county should pay (1) part of the expense of exterminating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it is advisable to clean up the herds within a township or possibly one-third or one-half of the area. The progress depends upon the degree of infection found and the cooperation furnished by the owners.

FIG. 13.—An accredited Guernsey herd, Wisconsin.

FIG. 14.—An accredited Ayrshire herd, West Virginia.

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin tested; of the total number, 321 cattle, or 18.87 per cent, were tuberculous. The reactors were removed from the herds and, in most instances, were slaughtered. The infected barns, sheds, and premises were cleaned and disinfected.

Each year since the inauguration of the campaign all the cattle have been tuberculin tested with the result that the infection has almost disappeared.

There are States in which tuberculosis exists to less than 1 per cent among all the bovine population. The plan of carrying on eradication in several counties at the same time in those States is practicable and is being conducted in a number of States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make, it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The larger herds, especially around cities and those supplying milk locally and for shipment to other cities, should be tested before the small lots. If it is known that the herds are but slightly infected, the intradermic method should be employed, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermic test, the entire herd should be tested subcutaneously within a short time. The ophthalmic test may also be used in conjunction with the subcutaneous in "check" testing

FIG. 15.—An accredited herd of pure-bred Milking Shorthorns, Virginia.

herds. General experience shows that it is sound practice, if there is any doubt, to use all three methods of testing with tuberculin. Such a policy is especially applicable to cattle which have been tested frequently, and among herds which are or have been extensively diseased.

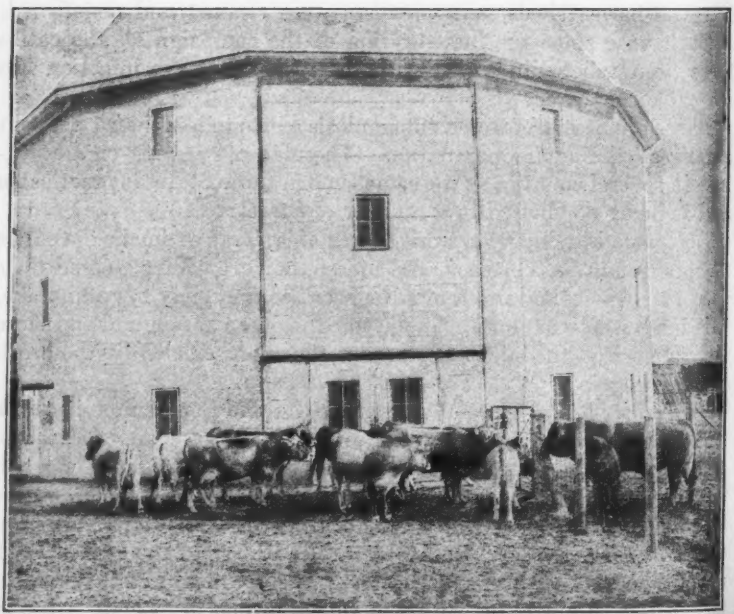

FIG. 16.—An accredited Brown Swiss herd, Indiana.

ERADICATION FROM SWINE.

With the gradual elimination of tuberculosis from cattle, the disease among swine will grow correspondingly smaller. It is not necessary to tuberculin test all the swine herds because, with the exception of valuable breeding animals, it is more economical to slaughter the diseased ones when fat than to undertake to exterminate the disease in any other way.

In the case of suspected, valuable pure-bred swine, their freedom from tuberculosis can be determined definitely by the intradermic method, which is practicable and reliable.

The injection is near the base of the left ear; the other ear acts as a check for comparison. A reaction is manifested by a swelling in the

FIG. 17.—An accredited Red Poll herd, Virginia.

region where the tuberculin was injected. The swelling may appear any time from the 24th to the 104th hour after injection and will remain for several days. As in the case of cattle, diseased swine should be removed from the farm, and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

MEASURES OF PREVENTION.

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regu-

lating the movements of cattle, and recently, with that object in view, action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the live-stock owner. It is he who must take a very important part all through the campaign of tuberculosis eradication, and if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped

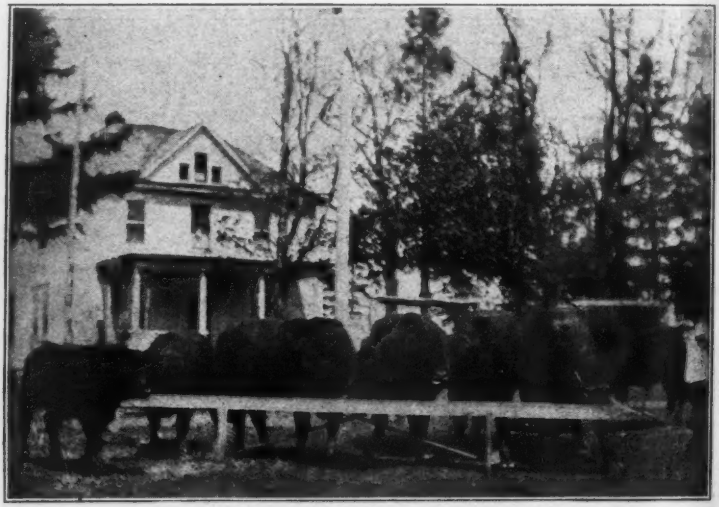

FIG. 15.—An accredited Aberdeen-Angus herd, Minnesota.

whenever possible. After diseased animals are found and removed from the premises, a *very thorough* cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant. The use of disinfectants without first doing the necessary and proper cleaning is ineffective for the reason that the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences can then be sprayed properly with the disinfectant.

FIG. 19.—An accredited Shorthorn herd, North Dakota.

All this means much work but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where live stock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

FIG. 20.—An accredited Hereford herd, Kentucky.

DISPOSAL OF REACTORS.

The disposal of reactors depends largely upon the State laws and live-stock regulations of the State in which the herd belongs. If the animals are pure bred and registered and of unusual merit, they should be segregated, preferably on farms set aside by the State or by the pure-bred cattle associations, for the purpose of retaining tuberculous cattle in quarantine. If the condemned animals are

FIG. 21.—An accredited Polled Durham herd, Minnesota.

THE ACCREDITED-HERD PLAN—EVERY CATTLE OWNER ELIGIBLE.

A tuberculosis-free accredited herd is one which has been tuberculin tested by the subcutaneous method or any other approved method under the supervision of the Bureau of Animal Industry, or of a regularly employed veterinary inspector of the State in which cooperative tuberculosis eradication is being conducted.

It is a herd in which no animal affected with tuberculosis has been found upon two annual or three semiannual tests, made as described, and by physical examination.

Owners of tuberculosis-free herds receive a certificate issued by the bureau and the State live-stock sanitary authorities. The certificate is good for one year from the date of the test, unless revoked at an earlier date.

grade cattle, or pure breds not specially valuable for breeding, it will probably be more economical to have them slaughtered than to hold them in quarantine. Of course the fact is recognized that in States and communities where tuberculosis exists extensively the slaughtering of all reactors is impracticable. In such instances the infection can be reduced on all the farms by keeping the tuberculous animals separate from the healthy ones. The tuberculous cattle are kept under quarantine restrictions until no longer profitable; meanwhile the healthy animals are safe from the danger of infection.

RETESTING.

It is rather uncommon for tuberculosis to be eradicated from an infected herd after one tuberculin test. After the removal of reactors the herd should be retested at the expiration of six months, and a second retest may be advisable six months later, but the practice of testing herds more frequently than that is not usually advised. After two or three semiannual tests the herd should not be tested oftener than every 12 months. While the subcutaneous test is considered preferable for gentle cattle, the ophthalmic and intradermic methods of testing may be employed to advantage as adjuncts to it; and it is believed that in some instances herds may be freed of tuberculosis earlier by the judicious use of all three methods. No general outline can be given as to when all three tests should be employed; the matter should be left to the judgment of the veterinarian under whose direction the work is carried on.

MARKING ANIMALS FOR IDENTIFICATION.

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified as affected with tuberculosis. One method that is quite generally used is that of branding; a letter "T" about 2 inches high is branded on the lower jaw, or sometimes it is placed on other parts of the body where it can be seen readily. In addition to the branding it is advisable to tag the reacting animals so that one may be identified from another, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is usually placed in the ear of the animal and contains a serial number as well as the word "Reactor."

Another method that is sometimes used is the punching of a letter "T" out of the ear, and it has been quite satisfactory.

The marking of cattle that have passed the tuberculin test is a matter that is being handled in different ways throughout the United States, and it is believed that the present methods of marking will be improved. In some cases a metal ear tag is used and in others certain marks of identification are tattooed in the ear. Tattooing

has an advantage over the tagging in that it is less expensive and probably more permanent.

It is not often necessary to require special marks on pure-bred registered cattle, as the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking that will show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine so that the origin of those found to be tuberculous on post-mortem examination can be learned would be very desirable, and some experimental work along this line is now being conducted by the bureau in cooperation with owners and packers. The results so far obtained indicate that the tattooing of a number or some mark of identification into the skin of the hog is the most practicable method but of course it entails additional labor and expense which would amount to a great deal if carried on throughout the country. It is hoped a more practicable and economical means of marking swine for identification will be developed in the future, as much good in the campaign for the eradication of tuberculosis in live stock can be accomplished in that way.

Many shipments which contain tuberculous swine are traced back to the farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised, efforts can be directed in eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY.

In addition to the various benefits derived from eradicating tuberculosis, provision for the appraisement of diseased cattle with indemnity for those slaughtered is a further incentive. Federal legislation and supplementary laws in numerous States now divide the burden

WHY THE TUBERCULIN TEST IS HARMLESS.

Tuberculin contains only the sterilized products of the tubercle bacilli. It does not contain any living germ; therefore it is harmless to any animal whether healthy or diseased.

Only diseased animals give typical reactions to the test. The test does not injure animals in a condition of advanced pregnancy, and will not cause them to react if they are free from disease.

Likewise, it does not produce reactions in disease-free animals which have recently calved.

HOW THE WORK OF ERADICATION IS DIVIDED BETWEEN STATE AND GOVERNMENT OFFICIALS AND OTHERS.

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the U. S. Department of Agriculture, the live-stock sanitary officials of the various States, and individual cattle owners. The bureau and the State officials send veterinary inspectors to apply tuberculin tests to the herds of those owners who sign a cooperative agreement, which places their herds jointly under supervision for the control and eradication of the disease.

of loss, so that the Government, the State, and the owner of the cattle all bear a share of it. Briefly, the Federal law provides that the Secretary of Agriculture may reimburse partly owners of animals destroyed on account of tuberculosis in cooperation with States, counties, and municipalities. The bases upon which Federal indemnities are paid are:

1. No payment shall exceed one-third of the difference between the appraised value of such animal and the salvage value.
2. No payment shall exceed the amount paid or to be paid by the State, county, or municipality.
3. In no case shall any payment be more than $25 for any grade animal or more than $50 for any pure-bred animal.
4. No payment shall be made unless the owner has complied with all lawful quarantine regulations.

Legislation regarding indemnities for tuberculous cattle varies somewhat in different States and, for detailed and current information on the subject, the reader is referred to his State live-stock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained by addressing the Bureau of Animal Industry U. S. Department of Agriculture.

A careful study of figures 4, 6, 7, and 8 in this bulletin will enable the reader to become familiar with the appearance of the parts of the body most commonly affected. He will also see, even more clearly than can be described, that a real danger exists in permitting diseased animals or those of doubtful health to mingle with others. The illustrations of the accredited herds, on the other hand, show the splendid types of cattle which their owners have subjected to the tuberculin test and which have passed it successfully.

XUM

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

April 20, 1924.

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This bulletin is a contribution from

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Tuberculosis Eradication Division	JOHN A. KIERNAN, *Chief.*

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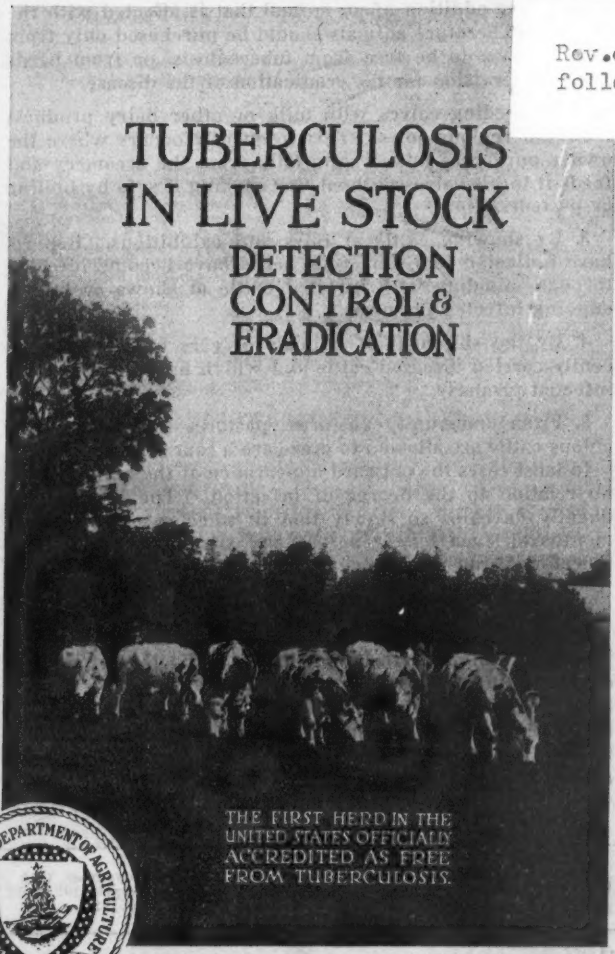
TUBERCULOSIS IN LIVE STOCK

DETECTION CONTROL & ERADICATION



THE FIRST HERD IN THE UNITED STATES OFFICIALLY ACCREDITED AS FREE FROM TUBERCULOSIS.

HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

1. By the addition of an animal that is affected with the disease. Therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

2. By feeding calves with milk or other dairy products from tuberculous cows. This frequently occurs where the owner purchases mixed skim milk from the creamery and feeds it to his calves without first making it safe by boiling or pasteurization.

3. By showing cattle at fairs and exhibitions. Reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

4. By the shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

5. From community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

COOPERATIVE WORK FOR TUBERCULOSIS ERADICATION

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the United States Department of Agriculture, the livestock sanitary officials of the various States, and individual cattle owners. The bureau and the State officials send veterinary inspectors to apply tuberculin tests to the herds of those owners who sign a cooperative agreement, which places their herds jointly under supervision for the control and eradication of the disease.

Washington, D. C.

Issued November, 1919
Revised April, 1924, and November, 1925

TUBERCULOSIS IN LIVESTOCK

DETECTION, CONTROL, AND ERADICATION

By JOHN A. KIERNAN, *Chief*, and ALEXANDER E. WIGHT, *Assistant Chief*, *Tuberculosis Eradication Division, Bureau of Animal Industry*

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PRESENT KNOWLEDGE OF TUBERCULOSIS

PROBABLY no disease affecting either the human race or livestock is better known or has been the object of so much study as tuberculosis. Present knowledge of the disease is derived from many sources, including the work of eminent scientists who discovered its cause, and studies of the numerous ways in which it is spread, of the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1882 by the eminent scientist Dr. Robert Koch. Thus the test has been known for more than a third of a century. The facts regarding it and other information presented in this bulletin are based upon long experience and results verified many times. The methods recommended to be used in the eradication of tuberculosis have been tried upon large numbers of herds and found to be effectual and practicable.

EARLY ERADICATION IS MOST ECONOMICAL

Livestock owners are earnestly requested not to wait until State and Federal officers come into their localities to eradicate tuberculosis. It would not be possible indeed at this stage to undertake to eradicate tuberculosis from the livestock of the United States solely through organized official forces established by the re-

spective States and the Federal Government. The area over which tuberculosis has spread is too vast, the herds are too numerous, and funds are insufficient for conducting the work on so extensive a plan, even though trained veterinarians were available in sufficient numbers to do the work. Every livestock owner should be a party to this campaign which has been inaugurated to eradicate tuberculosis. In almost every locality of the United States are veterinarians capable of rendering valuable services to livestock owners in this great work, and the cost of eradicating is greatly reduced by combating the disease in its early stages. Yet even in badly affected herds eradication can be undertaken with success. There are records of many herds, in which three-fourths of the animals were affected with tuberculosis, which eventually were freed from it and afterwards maintained in a healthy condition.

FIG. 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. On application of the tuberculin test, 37, or 82 per cent, of the animals were found to be tuberculous. The germs of the disease may live for months in manure or litter

The extirpation of tuberculosis from livestock is important not only from an economic standpoint, but also because a considerable percentage of tuberculosis in the human family, especially among children, is positively due to the consumption of infected milk or other dairy products from tuberculous cows. It is eminently proper for the respective State governments to expend funds for the maintenance of tuberculosis sanitariums for the care of persons afflicted with that disease, and likewise it is extremely important to use vigorous measures to check the marketing of germ-laden milk. While it is true that proper pasteurization of milk destroys the living organisms of tuberculosis, a large part of the milk consumed daily is not pasteurized, and some of the milk so treated is not always made entirely safe.

TUBERCULOSIS A DECEPTIVE DISEASE

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among the livestock owners, who would insist upon its immediate eradication; but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals (see fig. 1), many people believe that it does comparatively little damage among livestock. Contrary to such opinions, however, the loss from tuberculosis is one of the heaviest taxes imposed upon our livestock industry, amounting, probably, to at least $40,000,000 a year in the United States.

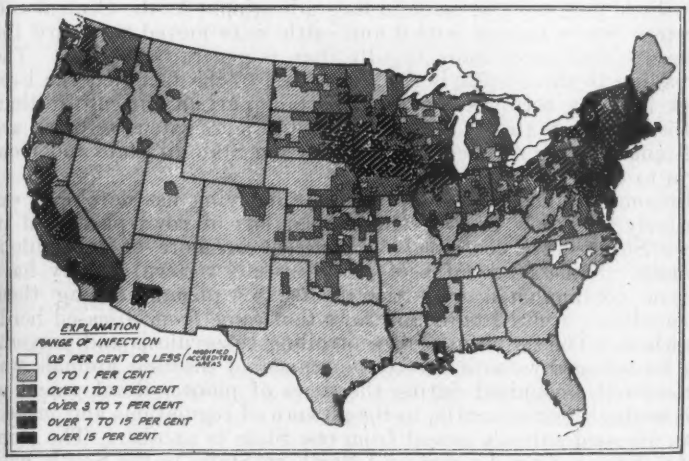
EXPLANATION
RANGE OF INFECTION
0.5 PER CENT OR LESS (MODIFIED ACCREDITED AREAS)
0 TO 1 PER CENT
OVER 1 TO 3 PER CENT
OVER 3 TO 7 PER CENT
OVER 7 TO 15 PER CENT
OVER 15 PER CENT

FIG. 2.—Extent of bovine tuberculosis in the United States (July 1, 1924)

PREVALENCE OF TUBERCULOSIS

In every State and Territory in the Union there is some tuberculosis among cattle and swine, though the degree varies considerably. An estimate of the extent of bovine tuberculosis is given in Table 1 and shown graphically in Figure 2.

TABLE 1.—*Estimated per cent of bovine tuberculosis in United States (calculated to July 1, 1924)*

Extent of infection	Area affected		Cattle (Jan. 1, 1924)		Degree of infection (per cent of reactors)
	Square miles	*Per cent*	*Number*	*Per cent*	
Modified accredited area (0.5 per cent or less by actual test)	21, 601	0. 7	445, 141	0. 6	0. 2
0 to 1 per cent	2, 044, 784	68. 8	34, 529, 163	50. 3	.5
Over 1 to 3 per cent	536, 961	18. 1	16, 993, 205	24. 8	2. 2
Over 3 to 7 per cent	193, 303	6. 5	8, 474, 381	12. 4	5. 1
Over 7 to 15 per cent	115, 402	3. 9	5, 165, 715	7. 5	10. 4
Over 15 per cent	60, 507	2. 0	2, 990, 008	4. 4	25. 5
Total	2, 972, 558	100. 0	68, 597, 613	100. 0	3. 3

Tuberculosis is known to exist also quite extensively among cattle and swine in all the European countries; in fact, no part of the world is known to be absolutely free from it. There are, however, some restricted regions where its presence is not known or it exists to but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States tuberculosis among livestock in those regions was unknown so far as we know. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but livestock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the livestock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

In some localities in the West where dairying has developed extensively it is now known that carload lots of cows purchased in other States have contained 50 per cent or more of tuberculous animals. Some herds of beef cattle in our western country have become contaminated with the disease by placing among them tuberculous purebred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is to-day. Consequently, in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick. Therefore there is probably less tuberculosis among the herds of the Southern States than in any other part of the Nation. This favorable condition should be taken advantage of, for in all probability the livestock industry will reach a high development in that area in future years. It is especially important that the herds of the Southern States be protected by permitting only tuberculosis-free animals to enter.

LOSSES OF MEAT FOOD PRODUCTS

Records kept by the Meat Inspection Division of the Bureau of Animal Industry show the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 per cent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 per cent of these classes of animals slaughtered each year in the United States do not appear in these

records. It is known also that the percentage of tuberculosis is greater in the uninspected animals. In view of these points the losses shown in Table 2 are believed to be scarcely one-half of the total loss throughout the country.

TABLE 2.—*Number of cattle and swine slaughtered, and those retained and condemned on account of tuberculosis, at establishments where Federal meat inspection is maintained*

Fiscal year	Cattle			Swine		
	Slaughtered	Retained [1]	Condemned	Slaughtered	Retained [1]	Condemned
1907 [2]	5, 867, 642	24, 876	17, 117	26, 189, 026	362, 445	48, 544
1908	7, 116, 275	68, 395	24, 371	35, 113, 077	719, 279	77, 554
1909	7, 325, 337	100, 650	24, 525	35, 427, 931	860, 425	45, 113
1910	7, 962, 189	123, 501	27, 638	27, 656, 021	792, 176	28, 880
1911	7, 781, 030	133, 551	27, 186	29, 916, 363	1, 117, 789	31, 517
1912	7, 532, 005	160, 122	35, 273	34, 966, 378	1, 643, 100	42, 267
1913	7, 155, 839	152, 560	33, 001	32, 287, 538	1, 809, 751	47, 632
1914	6, 724, 117	143, 699	29, 738	33, 289, 705	2, 201, 005	48, 252
1915	6, 964, 502	158, 239	32, 644	36, 247, 858	2, 774, 835	66, 023
1916	7, 404, 288	190, 991	37, 085	40, 482, 799	3, 687, 817	74, 109
1917	9, 299, 489	218, 928	46, 351	40, 210, 847	3, 978, 168	76, 807
1918	10, 938, 287	222, 787	40, 692	35, 449, 247	3, 494, 587	59, 740
1919	11, 241, 991	205, 698	37, 600	44, 398, 389	4, 103, 376	65, 837
1920	9, 709, 819	200, 647	37, 492	38, 981, 914	4, 260, 719	65, 609
1921	8, 179, 572	173, 658	33, 328	37, 702, 866	4, 693, 305	64, 830
1922	7, 871, 457	213, 606	39, 434	39, 416, 439	5, 640, 081	70, 304
1923	9, 029, 536	251, 299	49, 839	48, 600, 069	7, 139, 925	88, 688
1924	9, 188, 652	280, 905	56, 760	54, 416, 481	8, 293, 965	100, 110

[1] Held for more complete examination to determine final disposal.
[2] Covers 9 months from Oct. 1, 1906, to June 30, 1907.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is placed aside for further examination. If the disease is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed and the remainder is passed. It will be noted that such is the case in most carcasses retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In the animals that are retained and when the disease is not extensive enough to cause condemnation of the entire carcass the disease is in most cases in the early stages. Had the animals been allowed to live for possibly only a short time longer the disease would have progressed until all the carcass would have to be considered diseased. In others the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and endanger healthy cattle and swine.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of

diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from that farm.

CAUSE OF TUBERCULOSIS

The direct and primary cause of tuberculosis is a rod-shaped germ which can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or livestock is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures,

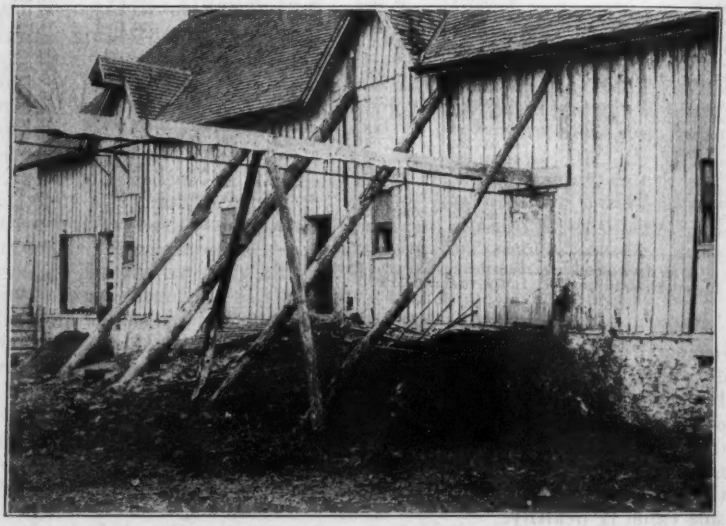

FIG. 3.—An insanitary barn. Nearly all the cows kept in it were tuberculous. The stone foundation wall retained about 2 feet of liquid manure which contained millions of tubercle germs. Premises of this character can not be kept sanitary

paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other inclosures which have contained tuberculous animals, before healthy ones are again placed in them.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuber-

culosis among the stock whenever the germs are present. (See figs. 3 and 4.) Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket that the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED

The tuberculous cow is the greatest source of danger to healthy cattle, and inasmuch as it can not be determined just when that animal becomes a "spreader" of the germs unless daily microscopic tests are made of the discharges from the body and the milk is also

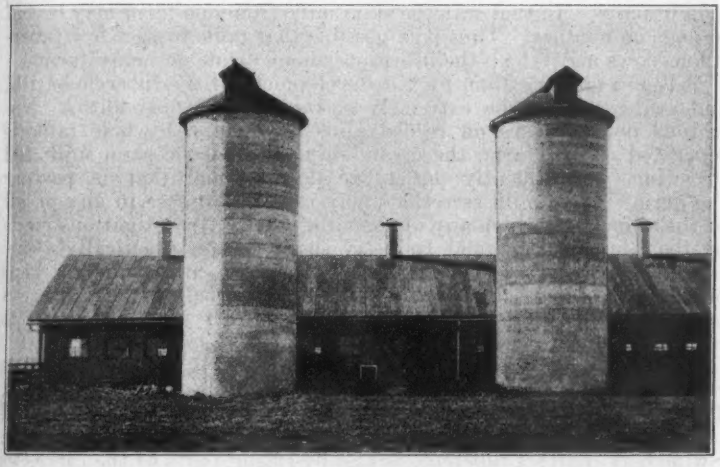

FIG. 4.—A modern sanitary barn. Note ventilators and liberal window space

examined microscopically, it is unsafe to keep it with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming into contact with affected animals than in any other way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

The continuous water trough in barns is also the cause to a very large extent of spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which infected milk or the washings from infected milk cans have been dumped may also be a source

of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected by drinking milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE BECOME INFECTED

The tuberculous cow is not only a menace to other cattle but is also the commonest source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the development of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record also in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are kept on the same farm, some of the latter are tuberculous. Eradication of tuberculosis from cattle, it is believed, will greatly reduce its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States, is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuberculosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another. Recent investigations indicate that a large percentage of hogs found to be slightly affected with tuberculosis have contracted the infection from poultry.

SYMPTOMS OF TUBERCULOSIS

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms. (See fig. 1.) Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When

tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening, as shown in Figure 5. Animals affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an animal are affected it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased

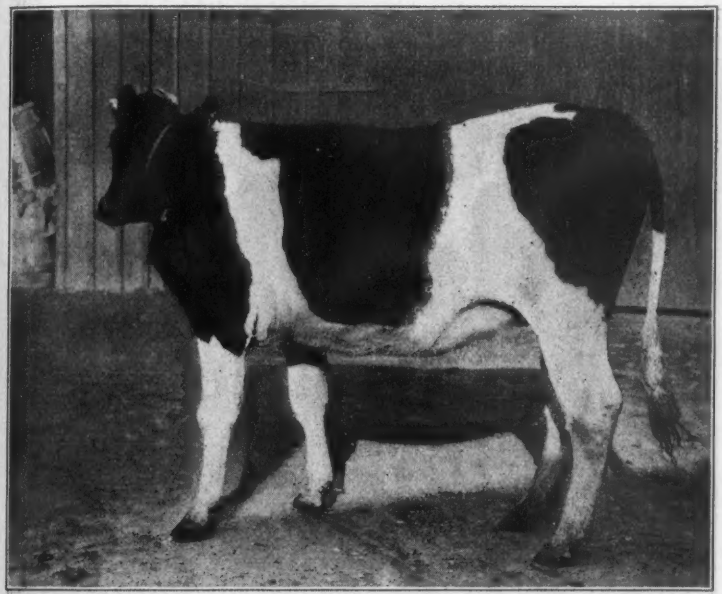

FIG. 5.—A tuberculous heifer. The gland at the shoulder was diseased and discharging tuberculous pus

respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased the animal often develops bloat (fig. 6). Diarrhea is often evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

METHODS OF DIAGNOSIS

Microscopic examinations of sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of

experience the tuberculin test is now considered to be the most practicable and satisfactory way of discovering the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

THE TUBERCULIN TEST

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-

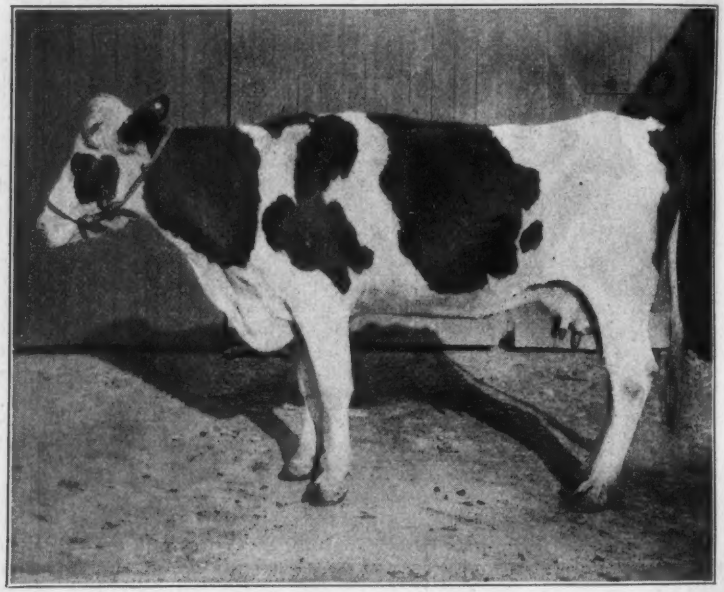

FIG. 6.—A reacting cow that was constantly "bloating." The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating

known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and in the hands of skillful persons, it is a reliable agent for detecting tuberculosis in animals. It contains no living tubercle bacilli but is a product of the growth of tubercle bacilli properly mixed with a substance on which it has grown and properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used.

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action.

Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to its application at another time; therefore it may be misused by unscrupulous persons.

THE SUBCUTANEOUS TEST (UNDER THE SKIN)

The subcutaneous test is made by injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to measure the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are measured at least three times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the person who applies the test, and a careful observance of any clinical changes is always important in determining the result. It can not be set forth too strongly that the test, including the two following methods, should be attempted only by those who are properly qualified to do the work.

THE INTRADERMIC TEST (INTO THE SKIN)

The intradermic test for detecting tuberculosis is used extensively. When made by those who have become skilled in its application it is very accurate. In this test the tuberculin is injected between the layers of the skin, only a few drops being used, and it is usually applied in the region at the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine, and when so used the tuberculin is applied into the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is usually observed from 72 to 120 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced person.

THE OPHTHALMIC TEST (INTO THE EYE)

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the previously described methods. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the

fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit.

In all cases the tests, used either alone or in combination, should be applied by capable persons familiar with tuberculin testing.

POST-MORTEM APPEARANCES

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs. The lesions are of various sizes and may contain pus, either soft or hard; many times it is gritty. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities. Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands, to some extent, are usually affected, and, when cut into, show diseased areas characteristic of tuberculosis.

FIG. 7. Part of a tuberculous udder showing well-developed lesions

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible for even a person skilled in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals that reacted to the test were not affected with tuberculosis to some extent, even though some were very slight.

Characteristic lesions of bovine tuberculosis are shown in Figures 7, 8, and 9.

METHODS OF ERADICATION

Cattle owners who do not know whether tuberculosis exists among their animals should ascertain the fact by having them tuberculin tested and physically examined by a qualified veterinarian. In

many cases thousands of dollars and very valuable breeding animals might have been saved by taking up tuberculosis-eradication work in time.

Three main projects comprise the general campaign of eradication, as follows:

1. Eradication of tuberculosis from purebred herds of cattle.
2. Eradication of tuberculosis from circumscribed areas.
3. Eradication of tuberculosis from swine.

It is important to eradicate tuberculosis from purebred herds of cattle at the earliest possible date because the spread of the disease is greater among such animals than among grade cattle. The reason is not that purebreds are any more susceptible, but that they are shipped extensively to every part of the United States for

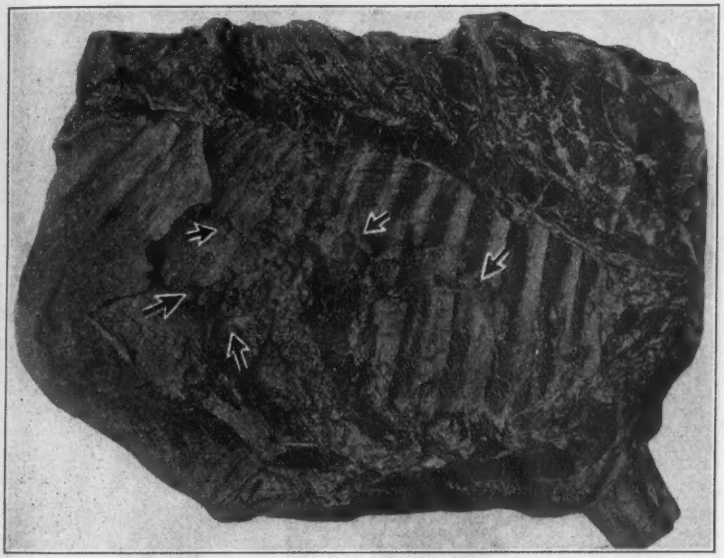

FIG. 8.—Beef carcass showing tuberculous nodules on ribs

breeding purposes. A purebred bull or cow may be shipped from Maine to Texas, or from the State of Washington to Florida. If it is diseased and is introduced into a healthy herd, it not only fails to fulfill the purpose for which it was intended—the upbreeding of the herd—but it actually causes heavy damage by spreading the disease to healthy animals. (See fig. 10.)

ACCREDITED-HERD OR HONOR-ROLL PLAN

The breeders of purebred registered cattle fully appreciated the above-mentioned fact when, together with the livestock sanitary officials of practically all the States, they adopted what is known as the accredited-herd plan, the principles of which are that herds found to be free from tuberculosis on two successive annual tests

are placed on the honor roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of one year. This plan is becoming well known to breeders throughout the United States.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for purebreds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly

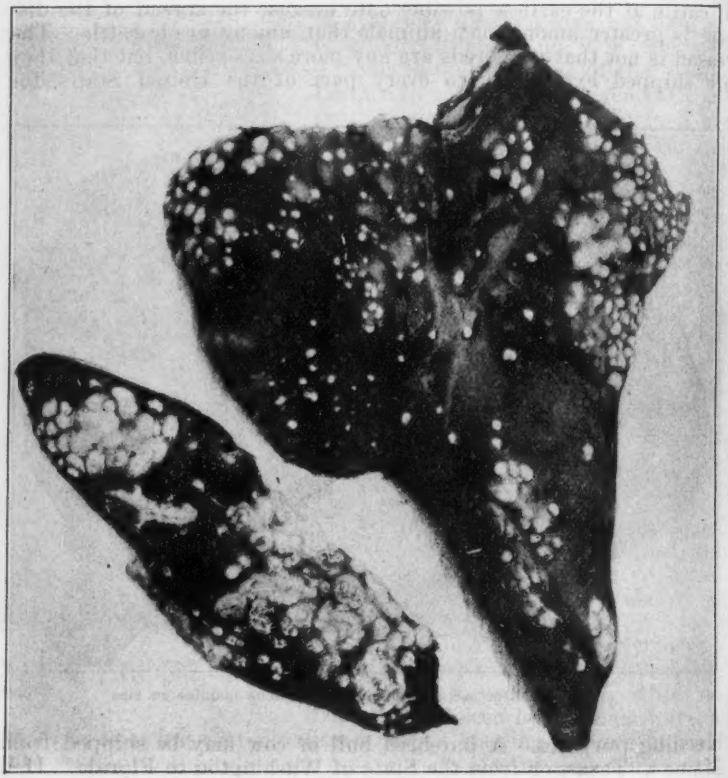

FIG. 9.—Liver and spleen showing extensive lesions of tuberculosis

tuberculin tested. To make a satisfactory test all the cattle should be in normal condition and, so far as practicable, the cattle should be stabled under usual conditions and among usual surroundings. Feeding and watering should be conducted in the customary manner, with the exception that feed and water should be given only after the temperature has been taken. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

ERADICATION FROM AREAS

The unit territory to be worked will depend mainly on the extent to which the disease has spread. In some States practically every county contains numerous tuberculous herds, so that, to control the disease effectively, all the herds must be tuberculin tested. In other States, however, the disease is confined to the beef and dairy herds recently established or to which new animals have lately been added. In the latter case it would not be necessary to test all the cattle, but the examination of the herds should be sufficient to demonstrate

FIG. 10.—How a herd may become reinfected with tuberculosis. This herd was free from tuberculosis for a number of years. During 1917, 4 cattle were purchased in another State and placed in the herd without proper tuberculin test. When official test was made, December, 1917, 5 reactors were found. Three of the reactors were slaughtered and 2 kept in the herd. At the next test, January, 1919, 11 reactors and 2 suspects were in the herd of 28 cattle

most satisfactorily that no diseased herds are overlooked. This can be done by testing several herds in each section of the county wherever there is a suspicion that the disease may exist.

As a general plan, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county should pay (1) part of the expense of exterminating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it is advisable to clean up the herds within a township or

possibly one-third or one-half of the area. The progress depends upon the degree of infection found and the cooperation furnished by the owners.

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin tested; of the total number, 321 cattle, or 18.87 per cent, were tuberculous. The reactors were removed from the herds and, in most instances, were slaughtered. The infected barns, sheds, and premises were cleaned and disinfected.

Each year since the inauguration of the campaign all the cattle have been tuberculin tested, with the result that the infection has almost disappeared.

There are States in which tuberculosis exists to less than 1 per cent among all the bovine population. The plan of carrying on eradica-

FIG. 11.—This Hereford herd was free from tuberculosis within 3 years. The first test, in 1916, showed the herd to be 10 per cent tuberculous. The reactors were removed and in 1918 all the 62 animals in the herd were found to be healthy.

tion in several counties at the same time in those States is practicable and is being conducted in a number of States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make, it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The larger herds, especially around cities, and those supplying milk locally and for shipment to other cities, should be tested before the small lots. If it is known that the herds are but slightly infected, the intradermic method should be employed, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermic test, the entire herd should be tested subcutaneously within a short time. The ophthalmic test may also be used in conjunction with the subcutaneous in "check" testing herds. General experience shows that it is sound practice, if there is

any doubt, to use all three methods of testing with tuberculin. Such a policy is especially applicable to cattle which have been tested frequently and among herds which are or have been extensively diseased.

When not more than one-half of 1 per cent of the cattle in a given area, usually a county, are found to be affected with tuberculosis, such area is declared to be a "modified accredited area." Cattle from such areas may be moved interstate without further tuberculin test. At several of the larger markets a premium of 10 cents a hundred pounds is paid for hogs from these areas. The

FIG. 12.—An accredited Jersey herd in Minnesota

first counties were accredited in July, 1923, and 82 counties had been accredited up to June 1, 1925.

ERADICATION FROM SWINE

With the gradual elimination of tuberculosis from cattle the disease among swine will grow correspondingly smaller. It is not necessary to tuberculin test all the swine herds because, with the exception of valuable breeding animals, it is more economical to slaughter the diseased ones when fat than to undertake to exterminate the disease in any other way.

In the case of suspected, valuable purebred swine their freedom from tuberculosis can be determined definitely by the intradermic method, which is practicable and reliable.

The injection made is near the base of the left ear; the other ear acts as a check for comparison. A reaction is manifested by a

swelling in the region where the tuberculin was injected. The swelling may appear any time from the 24th to the 104th hour after injection and will remain for several days. As in the case of cattle diseased swine should be removed from the farm and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

PROGRESS OF ERADICATION

The campaign for the systematic eradication of tuberculosis from livestock has met with increasing favor. Applications for testing are far in excess of the capacity of the available forces and appropriations, and there is always a waiting list of herd owners desiring to have their cattle tested. Table 3 shows the progress made.

TABLE 3.—*Status of cooperative tuberculosis-eradication work, including all herds under supervision, June 1, 1925*

State	Modified-accredited counties	Passed one test		Accredited		Under supervision	
		Herds	Cattle	Herds	Cattle	Herds	Cattle
Alabama		1,677	10,941	175	8,972	2,209	29,431
Arizona		3,143	68,771	18	1,134	4,069	73,012
Arkansas		2,924	13,505	52	1,926	3,111	17,691
California	2	2,082	102,394	77	3,415	2,241	127,603
Colorado		1,113	9,355	48	1,042	1,344	14,310
Connecticut		570	11,940	638	12,762	1,814	36,385
Delaware		1,803	6,890	938	4,701	3,335	15,150
District of Columbia		253	459	26	541	286	1,262
Florida	3	5,724	44,711	366	14,107	6,532	80,524
Georgia		5,860	82,993	39	2,433	6,703	111,280
Idaho	1	19,390	188,618	89	2,860	22,483	224,067
Illinois	1	63,355	486,456	982	25,262	77,456	698,114
Indiana	6	37,920	243,167	11,720	116,889	50,594	403,264
Iowa	4	54,193	845,766	5,351	127,146	88,027	1,584,099
Kansas	3	17,086	191,326	852	24,614	18,559	230,992
Kentucky		36,234	196,940	284	8,329	42,275	283,595
Louisiana		2,165	23,403	34	2,177	3,467	44,542
Maine		13,344	98,517	2,129	22,250	15,906	127,748
Maryland		4,440	29,964	1,530	18,388	10,498	87,029
Massachusetts		733	8,133	223	6,345	1,400	30,152
Michigan	6	61,726	480,408	182	4,589	64,401	519,035
Minnesota	3	12,632	250,917	5,798	127,244	20,116	428,465
Mississippi		1,613	21,924	121	3,874	1,754	27,865
Missouri		53,719	482,147	839	29,534	56,959	528,518
Montana		19,339	279,950	105	6,664	20,189	347,943
Nebraska	1	21,496	266,500	163	6,309	22,908	301,577
Nevada		2,123	53,964	9	720	2,782	69,906
New Hampshire		1,878	16,850	1,718	15,511	3,670	43,282
New Jersey		1,290	6,062	502	6,297	2,096	16,347
New Mexico		2,704	26,755	11	1,360	2,945	29,282
New York	1	23,990	227,278	12,427	158,096	46,926	633,501
North Carolina	35	151,186	401,550	117	3,139	165,082	448,075
North Dakota	5	19,028	332,259	2,890	61,454	24,942	465,855
Ohio		37,307	222,008	1,364	23,549	42,532	297,356
Oklahoma		92	4,024	276	8,285	378	12,462
Oregon	1	49,689	419,315	810	13,575	50,570	433,082
Pennsylvania	3	26,624	184,746	3,512	57,221	33,534	282,985
Rhode Island		11	132	39	997	68	1,567
South Carolina		822	9,626	178	5,551	5,612	31,232
South Dakota		649	17,210	433	13,655	1,252	36,787
Tennessee	3	12,555	83,373	230	8,224	12,840	92,581
Texas		800	22,186	274	10,929	1,255	45,327
Utah	1	10,011	58,872	80	2,306	10,969	84,158
Vermont		1,589	31,200	3,482	61,586	7,305	123,664
Virginia		5,902	30,168	1,537	43,510	7,750	84,423
Washington		30,922	274,954	109	4,180	33,073	312,589
West Virginia		5,754	45,678	592	7,878	6,548	67,807
Wisconsin		50,788	695,637	6,785	157,808	63,549	954,867
Wyoming		5,701	66,788	9	686	6,441	75,752
Total	82	885,949	7,676,730	70,163	1,250,024	1,080,755	11,016,737

MEASURES OF PREVENTION

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regulating the movements of cattle, and with that object in view, action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the livestock owner. It is he who must take a very important part all through the campaign of tuberculosis eradication, and if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped whenever possible. After diseased animals are found and removed from the premises, a *very thorough* cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant. The use of disinfectants without first doing the necessary and proper cleaning is ineffective for the reason that the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences can then be sprayed properly with the disinfectant.

All this means much work, but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where livestock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

DISPOSAL OF REACTORS

The disposal of reactors depends largely on the State laws and livestock regulations of the State in which the herd belongs. If the animals are purebred and registered and of unusual merit, they should be segregated, preferably on farms set aside by the State or by the purebred cattle associations, for the purpose of retaining tuberculous cattle in quarantine. If the condemned animals are grade cattle, or purebreds not specially valuable for breeding, it will probably be more economical to have them slaughtered than to hold them in quarantine. Of course the fact is recognized that in States and communities where tuberculosis exists extensively the slaughtering of all reactors is impracticable. In such instances the infection can be reduced on all the farms by keeping the tuberculous animals separate from the healthy ones. The tuberculous cattle are kept under quarantine restrictions until no longer profitable; meanwhile the healthy animals are safe from the danger of infection.

RETESTING

It is rather uncommon for tuberculosis to be eradicated from an infected herd after one tuberculin test. After the removal of reactors the herd should be retested at the expiration of six months, and a second retest may be advisable six months later, but the practice of testing herds more frequently than that is not usually advised. After two or three semiannual tests the herd should not be tested oftener than every 12 months. While the subcutaneous test is considered preferable for gentle cattle, the ophthalmic and intradermic methods of testing may be employed to advantage as adjuncts to it; and it is believed that in some instances herds may be freed of tuberculosis earlier by the judicious use of all three methods. No general outline can be given as to when all three tests should be employed; the matter should be left to the judgment of the veterinarian under whose direction the work is carried on.

MARKING ANIMALS FOR IDENTIFICATION

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified. One method that is quite generally used is that of branding; a letter "T" about 2 inches high is branded on the lower jaw, or sometimes it is placed on some other part of the body where it can be seen readily. In addition to the branding it is advisable to tag the reacting animals so that one may be identified from another, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is usually placed in the ear of the animal and contains a serial number as well as the word "Reactor."

Another method that is sometimes used is the punching of a letter "T" out of the ear, and it has been quite satisfactory.

The marking of cattle that have passed the tuberculin test is a matter that is being handled in different ways throughout the United States, and it is believed that the present methods of marking will be improved. In some cases a metal ear tag is used and in others certain marks of identification are tattooed in the ear. Tattooing has an advantage over the tagging in being less expensive and probably more permanent.

It is not often necessary to require special marks on purebred registered cattle, as the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking to show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine so that the origin of those found to be tuberculous on post-mortem examination can be learned would be very desirable, and some experimental work along this line is now being conducted by the bureau in cooperation with owners and packers. The results so far obtained indicate that the tattooing of a number or some mark of identification into the skin of the hog is the most practicable method, but of course it entails additional labor and expense which would amount to a great deal if carried on throughout the country. It is hoped that a more practicable and

economical means of marking swine for identification will be developed in the future, as much good in the campaign for the eradication of tuberculosis in livestock can be accomplished in that way.

Many shipments which contain tuberculous swine are traced back to the farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised efforts can be directed in eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY

In addition to the various benefits derived from eradicating tuberculosis provision for the appraisement of diseased cattle with indemnity for those slaughtered is a further incentive. Federal legislation and supplementary laws in numerous States now divide the burden of loss, so that the Government, the State, and the owner of the cattle all bear a share of it. Briefly, the Federal law provides that the Secretary of Agriculture may reimburse in part owners of animals destroyed on account of tuberculosis in cooperation with States, counties, and municipalities. The bases upon which Federal indemnities are paid are:

1. No payment shall exceed one-third of the difference between the appraised value of such animal and the salvage value.
2. No payment shall exceed the amount paid or to be paid by the State, county, or municipality.
3. In no case shall any payment be more than $25 for any grade animal or more than $50 for any purebred animal.
4. No payment shall be made unless the owner has complied with all lawful quarantine regulations.

Legislation regarding indemnities for tuberculous cattle varies somewhat in different States, and for detailed and current information on the subject the reader is referred to his State livestock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained by addressing the Bureau of Animal Industry, U. S. Department of Agriculture.

A careful study of Figures 5, 7, 8, and 9 in this bulletin will enable the reader to become familiar with the appearance of the parts of the body most commonly affected. He will also see, even more clearly than can be described, that a real danger exists in permitting diseased animals or those of doubtful health to mingle with others. The illustrations of the accredited herds, on the other hand, show the splendid types of cattle which their owners have subjected to the tuberculin test and which have passed it successfully.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

October 6, 1925

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This bulletin is a contribution from

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Tuberculosis Eradication Division	JOHN A. KIERNAN, *Chief.*

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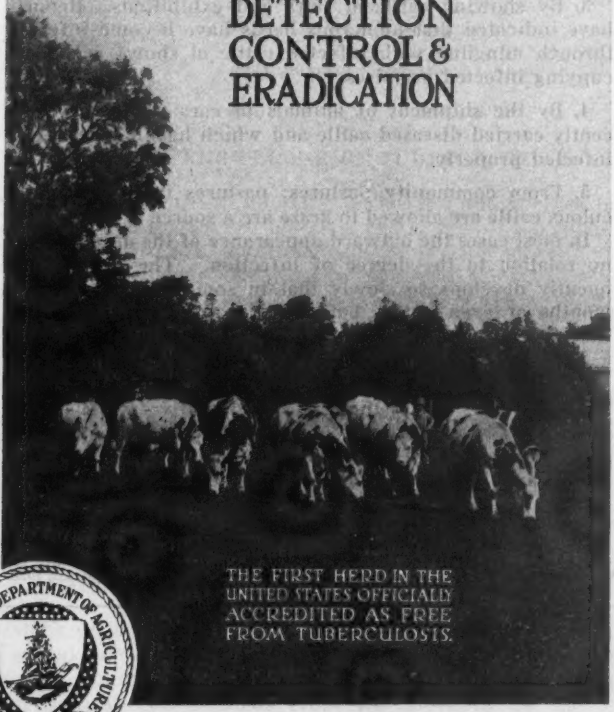
TUBERCULOSIS IN LIVE STOCK

DETECTION CONTROL & ERADICATION



THE FIRST HERD IN THE UNITED STATES OFFICIALLY ACCREDITED AS FREE FROM TUBERCULOSIS.

HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

1. By the addition of an animal that is affected with the disease. Therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

2. By feeding calves with milk or other dairy products from tuberculous cows. This frequently occurs where the owner purchases mixed skim milk from the creamery and feeds it to his calves without first making it safe by boiling or pasteurization.

3. By showing cattle at fairs and exhibitions. Reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

4. By the shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

5. From community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

COOPERATIVE WORK FOR TUBERCULOSIS ERADICATION

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the United States Department of Agriculture, the livestock sanitary officials of the various States, and individual cattle owners

Washington, D. C.

Issued November, 1919
Revised August, 1928

TUBERCULOSIS IN LIVESTOCK

DETECTION, CONTROL, AND ERADICATION

By JOHN A. KIERNAN,[1] *Chief*, and ALEXANDER E. WIGHT, *Assistant Chief, Tuberculosis Eradication Division, Bureau of Animal Industry*

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PRESENT KNOWLEDGE OF TUBERCULOSIS

PROBABLY no disease affecting either the human race or livestock is better known or has been the object of so much study as tuberculosis. Present knowledge of the disease is derived from many sources, including the work of eminent scientists who discovered its cause, and studies of the numerous ways in which it is spread, of the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1890 by the eminent scientist Dr. Robert Koch. Thus the test has been known for more than a third of a century. The facts regarding it and other information presented in this bulletin are based upon long experience and results verified many times. The methods recommended to be used in the eradication of tuberculosis have been tried upon large numbers of herds and found to be effectual and practicable.

EARLY ERADICATION IS MOST ECONOMICAL

Livestock owners are earnestly requested not to wait until State and Federal officers come into their localities to eradicate tuberculosis. It would not be possible indeed at this stage to undertake to eradicate tuberculosis from the livestock of the United States solely through organized official forces established by the re-

[1] Doctor Kiernan died in December, 1927, and Doctor Wight became chief of division on January 1, 1928.

spective States and the Federal Government. The area over which tuberculosis has spread is too vast, the herds are too numerous, and funds are insufficient for conducting the work on so extensive a plan, even though trained veterinarians were available in sufficient numbers to do the work. Every livestock owner should be a party to this campaign which has been inaugurated to eradicate tuberculosis. In almost every locality of the United States are veterinarians capable of rendering valuable services to livestock owners in this great work, and the cost of eradicating is greatly reduced by combating the disease in its early stages. Yet even in badly affected herds eradication can be undertaken with success. There are records of many herds, in which three-fourths of the animals were affected with tuberculosis, which eventually were freed from it and afterwards maintained in a healthy condition.

FIG. 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. On application of the tuberculin test, 37, or 82 per cent, of the animals were found to be tuberculous. The germs of the disease may live for months in manure or litter

The extirpation of tuberculosis from livestock is important not only from an economic standpoint, but also because a considerable percentage of tuberculosis in the human family, especially among children, is positively due to the consumption of infected milk or other dairy products from tuberculous cows. It is eminently proper for the respective State governments to expend funds for the maintenance of tuberculosis sanitariums for the care of persons afflicted with that disease, and likewise it is extremely important to use vigorous measures to check the marketing of germ-laden milk. While it is true that proper pasteurization of milk destroys the living organisms of tuberculosis, a large part of the milk consumed daily is not pasteurized, and some of the milk so treated is not always made entirely safe.

TUBERCULOSIS A DECEPTIVE DISEASE

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among the livestock owners, who would insist upon its immediate eradication; but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals (see fig. 1), many people believe that it does comparatively little damage among livestock. Contrary to such opinions, however, the loss from tuberculosis is one of the heaviest taxes imposed upon our livestock industry, amounting, probably, to at least $40,000,000 a year in the United States.

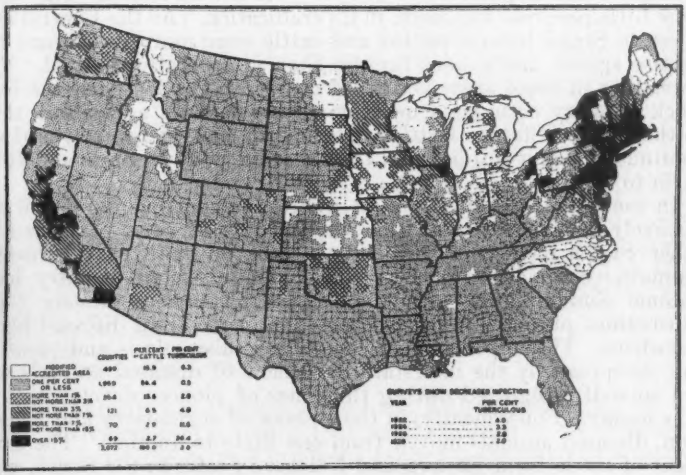

FIG. 2.—Extent of bovine tuberculosis in the United States, May 1, 1928

PREVALENCE OF TUBERCULOSIS

In every State and Territory in the Union there is some tuberculosis among cattle and swine, though the degree varies considerably. An estimate of the extent of bovine tuberculosis is given in Table 1 and shown graphically in Figure 2.

TABLE 1.—*Estimated percentage of bovine tuberculosis in the United States (calculated to May 1, 1928)*

Extent of infection	Area affected				Cattle in area	Degree of infection (per cent of reactors)
	Counties	*Per cent*	*Square miles*	*Per cent*	*Per cent*	
Modified accredited area (0.5 per cent or less by actual test)	499	16.2	373,178	12.6	15.9	0.3
0 to 1 per cent	1,959	63.8	2,094,432	70.5	56.4	.5
Over 1 to 3 per cent	354	11.5	290,510	9.8	15.6	2.0
Over 3 to 7 per cent	121	3.9	107,056	3.6	6.5	4.8
Over 7 to 15 per cent	70	2.3	59,427	2.0	2.9	11.6
Over 15 per cent	69	2.3	45,007	1.5	2.7	26.4
Total or average	3,072	100.0	2,969,610	100.0	100.0	2.0

Tuberculosis is known to exist also quite extensively among cattle and swine in all the European countries; in fact, no part of the world is known to be absolutely free from it. There are, however, some restricted regions where its presence is not known or it exists to but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States tuberculosis among livestock in those regions was unknown so far as we know. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but livestock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the livestock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

In some localities in the West where dairying has developed extensively it is now known that carload lots of cows purchased in other States have contained 50 per cent or more of tuberculous animals. Some herds of beef cattle in our western country have become contaminated with the disease by placing among them tuberculous purebred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is to-day. Consequently, in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick. Therefore there is probably less tuberculosis among the herds of the Southern States than in any other part of the Nation. This favorable condition should be taken advantage of, for in all probability the livestock industry will reach a high development in that area in future years. It is especially important that the herds of the Southern States be protected by permitting only tuberculosis-free animals to enter.

LOSSES OF MEAT FOOD PRODUCTS

Records kept by the Meat Inspection Division of the Bureau of Animal Industry show the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 per cent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 per cent of these classes of animals slaughtered each year in the United States do not appear in these

records. It is known also that the percentage of tuberculosis is greater in the uninspected animals. In view of these points the losses shown in Table 2 are believed to be scarcely one-half of the total loss throughout the country.

TABLE 2.—*Number of cattle and swine slaughtered, and those retained and condemned on account of tuberculosis, at establishments where Federal meat inspection is maintained*

Fiscal year	Cattle			Swine		
	Slaughtered	Retained [1]	Condemned	Slaughtered	Retained [1]	Condemned
1907 [2]	5,867,642	24,876	17,117	26,189,026	362,445	48,544
1908	7,116,275	68,395	24,371	35,113,077	719,279	77,554
1909	7,325,337	100,650	24,525	35,427,931	860,425	45,113
1910	7,962,189	123,501	27,638	27,656,021	792,176	28,886
1911	7,781,030	133,551	27,186	29,916,363	1,117,789	31,517
1912	7,532,005	160,122	35,273	34,966,378	1,643,100	42,267
1913	7,155,839	152,560	33,001	32,287,538	1,809,751	47,632
1914	6,724,117	143,699	29,738	33,289,705	2,201,005	48,252
1915	6,964,502	158,239	32,644	36,247,855	2,774,835	66,023
1916	7,404,288	190,991	37,085	40,482,799	3,687,817	74,109
1917	9,299,489	218,928	46,351	40,210,847	3,978,168	76,807
1918	10,938,287	222,787	40,692	35,449,247	3,494,587	59,740
1919	11,241,991	205,698	37,600	44,398,389	4,103,376	65,837
1920	9,709,819	200,647	37,492	38,981,914	4,260,719	65,609
1921	8,179,572	173,658	33,328	37,702,866	4,693,305	64,830
1922	7,871,457	213,606	39,434	39,416,439	5,640,081	70,304
1923	9,029,536	251,299	49,839	48,600,069	7,139,925	88,688
1924	9,188,652	280,905	56,760	54,416,481	8,293,965	100,110
1925	9,773,883	322,925	61,104	48,459,608	7,039,724	86,282
1926	10,098,121	419,028	70,604	40,442,730	5,967,093	63,748
1927	10,049,589	351,716	53,512	42,650,443	5,778,009	59,656

[1] Held for more complete examination to determine final disposal.
[2] Covers 9 months from Oct. 1, 1906, to June 30, 1907.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is placed aside for further examination. If the disease is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed and the remainder is passed. It will be noted that such is the case in most carcasses retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In the animals that are retained and when the disease is not extensive enough to cause condemnation of the entire carcass the disease is in most cases in the early stages. Had the animals been allowed to live for possibly only a short time longer the disease would have progressed until all the carcass would have to be considered diseased. In others the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and endanger healthy cattle and swine.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of

diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from that farm.

CAUSE OF TUBERCULOSIS

The direct and primary cause of tuberculosis is a rod-shaped germ which can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or livestock is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures,

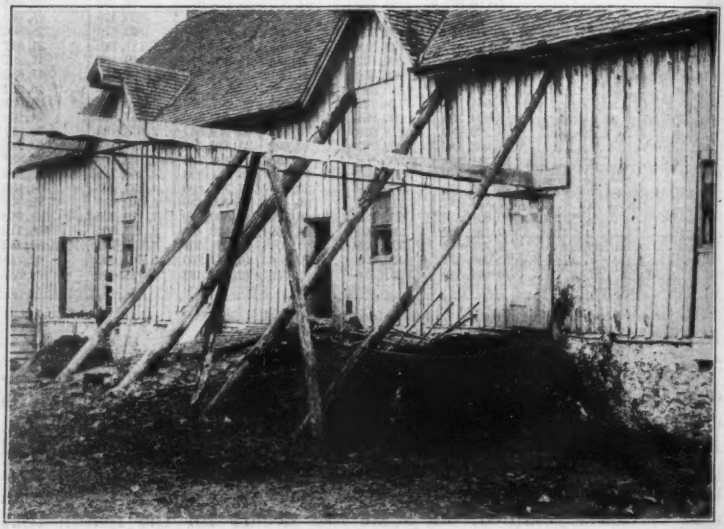

FIG. 3.—An insanitary barn. Nearly all the cows kept in it were tuberculous. The stone foundation wall retained about 2 feet of liquid manure which contained millions of tubercle germs. Premises of this character can not be kept sanitary

paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other inclosures which have contained tuberculous animals, before healthy ones are again placed in them.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuber-

culosis among the stock whenever the germs are present. (See figs. 3 and 4.) Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket that the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED

The tuberculous cow is the greatest source of danger to healthy cattle, and inasmuch as it can not be determined just when that animal becomes a "spreader" of the germs unless daily microscopic tests are made of the discharges from the body and the milk is also

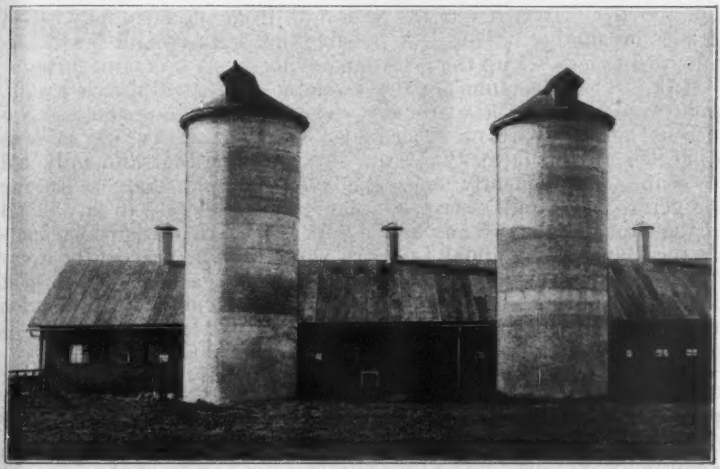

FIG. 4.—A modern sanitary barn. Note ventilators and liberal window space

examined microscopically, it is unsafe to keep it with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming into contact with affected animals than in any other way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

The continuous water trough in barns is also the cause to a very large extent of spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which infected milk or the washings from infected milk cans have been dumped may also be a source

of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected by drinking milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE BECOME INFECTED

The tuberculous cow is not only a menace to other cattle but is also the commonest source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the development of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record also in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are kept on the same farm, some of the latter are tuberculous. Eradication of tuberculosis from cattle, it is believed, will greatly reduce its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States, is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuberculosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another. Recent investigations indicate that a large percentage of hogs found to be slightly affected with tuberculosis have contracted the infection from poultry.[2]

SYMPTOMS OF TUBERCULOSIS

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms. (See fig. 1.) Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When

[2] Farmers' Bulletin 1200 describes and gives information on fowl tuberculosis.

tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening, as shown in Figure 5. Animals affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an animal are affected it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased

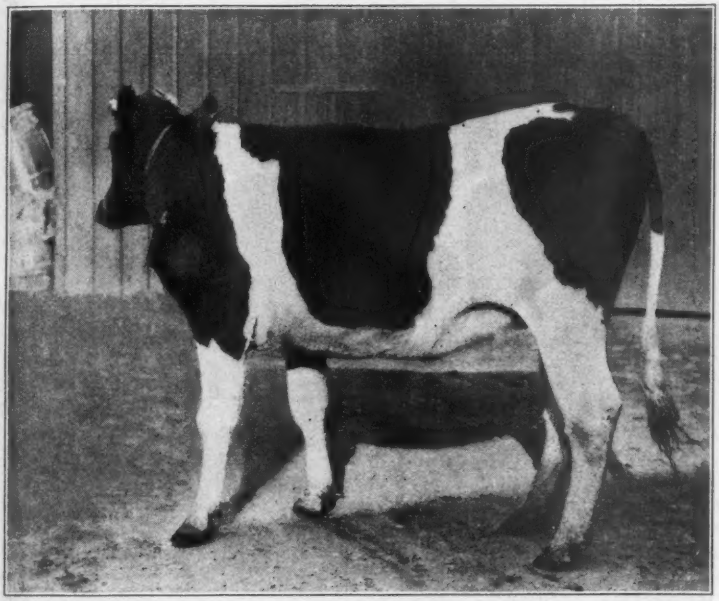

FIG. 5.—A tuberculous heifer. The gland at the shoulder was diseased and discharging tuberculous pus

respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased the animal often develops bloat (fig. 6). Diarrhea is often evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

METHODS OF DIAGNOSIS

Microscopic examinations of sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of

experience the tuberculin test is now considered to be the most practicable and satisfactory way of discovering the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

THE TUBERCULIN TEST

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-

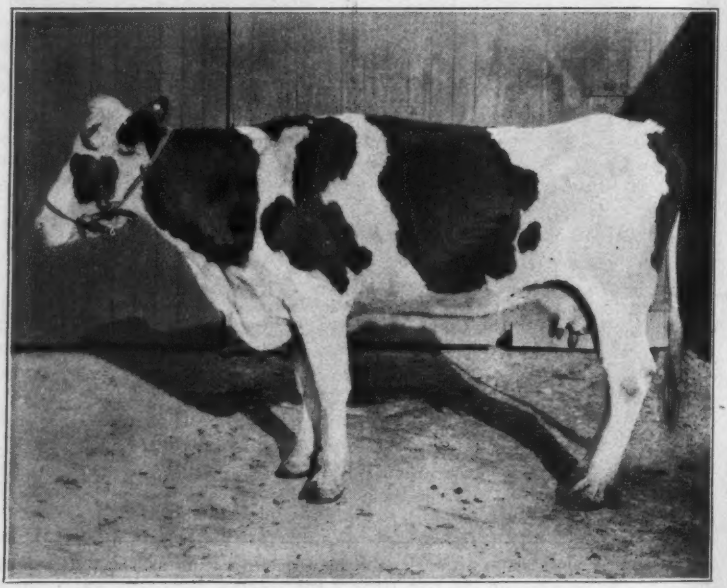

FIG. 6.—A reacting cow that was constantly "bloating." The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating

known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and in the hands of skillful persons, it is a reliable agent for detecting tuberculosis in animals. It contains no living tubercle bacilli but is a product of the growth of tubercle bacilli properly mixed with a substance on which it has grown and properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used.

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action.

Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to its application at another time; therefore it may be misused by unscrupulous persons.

THE SUBCUTANEOUS TEST (UNDER THE SKIN)

The subcutaneous test is made by injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to measure the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are measured at least three times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the person who applies the test, and a careful observance of any clinical changes is always important in determining the result. It can not be set forth too strongly that the test, including the two following methods, should be attempted only by those who are properly qualified to do the work.

THE INTRADERMIC TEST (INTO THE SKIN)

The intradermic test for detecting tuberculosis is used extensively. When made by those who have become skilled in its application it is very accurate. In this test the tuberculin is injected between the layers of the skin, only a few drops being used, and it is usually applied in the region at the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine, and when so used the tuberculin is applied into the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is usually observed from 72 to 120 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced person.

THE OPHTHALMIC TEST (INTO THE EYE)

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the previously described methods. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the

fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit.

In all cases the tests, used either alone or in combination, should be applied by capable persons familiar with tuberculin testing.

POST-MORTEM APPEARANCES

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs. The lesions are of various sizes and may contain pus, either soft or hard; many times it is gritty. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities. Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands, to some extent, are usually affected, and, when cut into, show diseased areas characteristic of tuberculosis.

FIG. 7.—Part of a tuberculous udder showing well-developed lesions

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible for even a person skilled in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals that reacted to the test were not affected with tuberculosis to some extent, even though some were very slight.

Characteristic lesions of bovine tuberculosis are shown in Figures 7, 8, and 9.

METHODS OF ERADICATION

Cattle owners who do not know whether tuberculosis exists among their animals should ascertain the fact by having them tuberculin tested and physically examined by a qualified veterinarian. In

many cases thousands of dollars and very valuable breeding animals might have been saved by taking up tuberculosis-eradication work in time.

Three main projects comprise the general campaign of eradication, as follows:

1. Eradication of tuberculosis from purebred herds of cattle.
2. Eradication of tuberculosis from circumscribed areas.
3. Eradication of tuberculosis from swine.

It is important to eradicate tuberculosis from purebred herds of cattle at the earliest possible date because the spread of the disease is greater among such animals than among grade cattle. The reason is not that purebreds are any more susceptible, but that they are shipped extensively to every part of the United States for

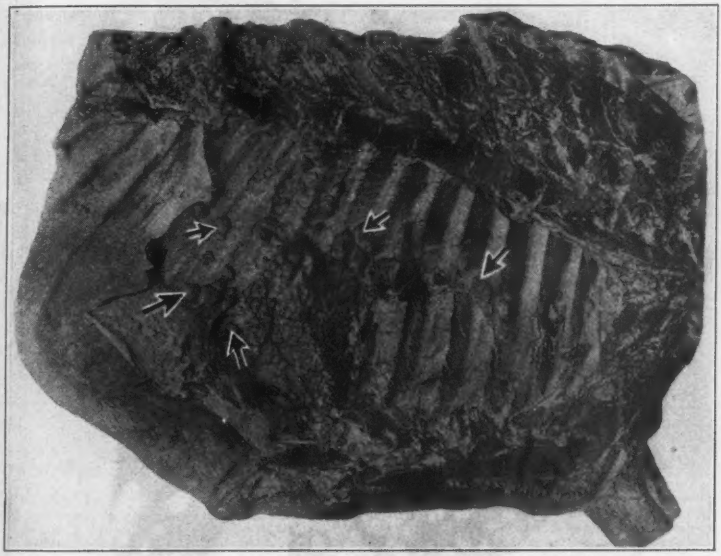

FIG. 8.—Beef carcass showing tuberculous nodules on ribs

breeding purposes. A purebred bull or cow may be shipped from Maine to Texas, or from the State of Washington to Florida. If it is diseased and is introduced into a healthy herd, it not only fails to fulfill the purpose for which it was intended—the upbreeding of the herd—but it actually causes heavy damage by spreading the disease to healthy animals. (See fig. 10.)

ACCREDITED-HERD OR HONOR-ROLL PLAN

The breeders of purebred registered cattle fully appreciated the above-mentioned fact when, together with the livestock sanitary officials of practically all the States, they adopted what is known as the accredited-herd plan, the principles of which are that herds found to be free from tuberculosis on two successive annual tests

are placed on the honor roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of one year. This plan is becoming well known to breeders throughout the United States.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for purebreds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly

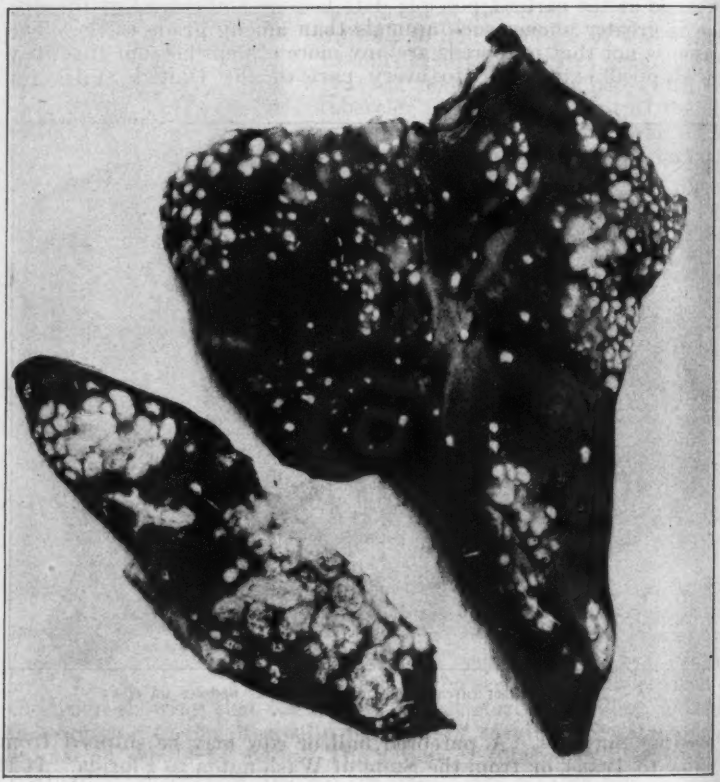

FIG. 9.—Liver and spleen showing extensive lesions of tuberculosis

tuberculin tested. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

ERADICATION FROM AREAS

As a general plan, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county should pay (1) part of the expense of extermi-

nating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it is advisable to clean up the herds within a township or possibly one-third or one-half of the area. The progress depends upon the degree of infection found and the cooperation furnished by the owners.

FIG. 10.—How a herd may become reinfected with tuberculosis. This herd was free from tuberculosis for a number of years. During 1917, 4 cattle were purchased in another State and placed in the herd without proper tuberculin test. When official test was made, December, 1917, 5 reactors were found. Three of the reactors were slaughtered and 2 kept in the herd. At the next test, January, 1919, 11 reactors and 2 suspects were in the herd of 28 cattle

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin tested; of the total number, 321 cattle, or 18.87 per cent, were tuberculous. The reactors were removed from the herds and, in most instances, were slaughtered. The infected barns, sheds, and premises were cleaned and disinfected.

Each year since the inauguration of the campaign all the cattle have been tuberculin tested, with the result that the infection has almost disappeared.

The plan of carrying on eradication under the area plan is practicable and is being conducted in many States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make, it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The intradermic method should be used, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermic test, the entire herd should be tested within from 60 to 90 days, using the ophthalmic test as a check. General experience shows that it is sound practice, if there is any doubt, to use all three methods of testing with tuberculin. Such a policy is

FIG. 11.—This Hereford herd was free from tuberculosis within 3 years. The first test, in 1916, showed the herd to be 10 per cent tuberculous. The reactors were removed and in 1918 all the 62 animals in the herd were found to be healthy

especially applicable to cattle which have been tested frequently and among herds which are or have been extensively diseased.

When not more than one-half of 1 per cent of the cattle in a given area, usually a county, are found to be affected with tuberculosis, such area is declared to be a "modified accredited area." Cattle from such areas may be moved interstate without further tuberculin test. At several of the larger markets a premium of 10 cents a hundred pounds is paid for hogs from these areas. The first counties were accredited in July, 1923, and 499 counties had been accredited up to May 1, 1928. Eradication work under the area plan is in operation in approximately 600 additional counties.

ERADICATION FROM SWINE

With the gradual elimination of tuberculosis from cattle and poultry the disease among swine will grow correspondingly smaller. It

is not necessary to tuberculin test all the swine herds because, with the exception of valuable breeding animals, it is more economical to slaughter the diseased ones when fat than to undertake to exterminate the disease in any other way.

In the case of suspected valuable purebred swine, their freedom from tuberculosis can be determined definitely by the intradermic method, which is practicable and reliable.

The injection made is near the base of the left ear; the other ear acts as a check for comparison. A reaction is manifested by a

FIG. 12.—An accredited Jersey herd in Minnesota

swelling in the region where the tuberculin was injected. The swelling may appear any time from the 24th to the 104th hour after injection and will remain for several days. As in the case of cattle, diseased swine should be removed from the farm, and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

PROGRESS OF ERADICATION

The campaign for the systematic eradication of tuberculosis from livestock has met with increasing favor. Applications for testing are far in excess of the capacity of the available forces and appropriations, and there is always a waiting list of herd owners

desiring to have their cattle tested. Tables 3 and 4 show the progress made.

TABLE 3.—*Status of cooperative tuberculosis-eradication work, including all herds under supervision May 1, 1928*

State	Modified-accredited counties	Passed one test		Accredited		Under supervision	
		Herds	Cattle	Herds	Cattle	Herds	Cattle
Alabama		4,975	49,693	228	13,453	7,396	72,501
Arizona		8,099	98,193	43	2,382	8,168	100,614
Arkansas		2,888	12,052	16	620	2,929	12,474
California	2	5,491	201,349	133	7,257	5,678	241,346
Colorado		3,087	20,929	159	4,553	3,642	34,796
Connecticut		4,213	26,711	1,484	28,940	7,104	73,263
Delaware		2,921	10,484	1,751	8,614	5,459	22,717
District of Columbia		90	545	8	332	99	901
Florida		7,400	78,682	430	18,671	8,267	121,530
Georgia	1	8,566	64,465	35	2,332	8,636	68,161
Idaho	18	29,877	321,207	54	2,029	33,243	370,380
Illinois	8	122,300	849,719	1,394	40,171	137,134	1,202,708
Indiana	36	97,155	590,600	36,077	275,481	139,655	919,050
Iowa	40	94,102	1,289,217	8,008	183,751	156,323	2,643,532
Kansas	32	68,756	723,666	854	23,985	70,291	758,065
Kentucky	8	70,245	476,339	63	2,677	71,656	496,594
Louisiana		6,862	66,930	19	1,120	7,192	70,667
Maine	12	32,715	188,084	4,001	24,439	36,922	213,863
Maryland		9,820	66,295	5,426	62,484	22,810	153,940
Massachusetts		1,623	10,624	753	13,803	2,923	33,572
Michigan	53	151,409	1,196,987	78	3,458	155,755	1,230,494
Minnesota	14	54,074	943,142	8,375	175,055	66,858	1,209,429
Mississippi	2	7,719	64,109	32	2,309	7,751	66,318
Missouri	6	63,281	561,823	975	33,900	66,800	613,761
Montana	5	29,386	363,049	93	6,728	29,977	512,515
Nebraska	29	63,089	763,781	111	4,695	63,989	784,038
Nevada		1,052	15,675	11	789	1,300	33,774
New Hampshire		2,243	20,349	3,124	33,400	5,746	63,256
New Jersey		3,022	9,979	1,838	10,611	6,495	28,016
New Mexico		1,099	12,545	18	1,680	1,154	14,486
New York	7	38,896	294,830	54,473	514,346	106,896	1,128,152
North Carolina	91	249,489	648,365	368	11,576	250,236	662,633
North Dakota	24	41,299	648,968	4,927	99,666	51,388	865,347
Ohio	19	143,168	882,322	530	9,821	148,713	1,049,283
Oklahoma		103	3,700	280	9,672	401	14,226
Oregon	4	37,767	263,947	436	9,580	38,239	273,610
Pennsylvania	12	90,848	494,585	4,405	80,385	109,282	755,493
Rhode Island		160	1,677	58	1,207	393	5,415
South Carolina	6	42,333	112,490	117	3,965	42,516	118,394
South Dakota	4	8,844	159,206	1,181	27,985	10,282	193,904
Tennessee	3	43,353	162,512	314	10,519	43,778	176,772
Texas		102	2,707	183	8,379	541	20,633
Utah	1	10,724	65,647	79	2,250	11,548	92,187
Vermont	(1)	3,197	47,550	5,457	102,847	11,913	182,091
Virginia	9	18,075	78,692	2,233	54,698	20,593	145,383
Washington	[2] 4	37,604	334,915	48	2,284	40,408	427,295
West Virginia	10	32,537	142,390	1,140	14,761	34,283	177,394
Wisconsin	27	128,028	1,946,145	10,925	235,004	138,364	2,193,678
Wyoming		9,172	105,141	4	345	10,378	121,421
Total	487	1,893,258	15,493,012	162,749	2,188,909	2,211,504	20,776,112

[1] 17 towns. [2] Includes part of 1 county.

MEASURES OF PREVENTION

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regulating the movements of cattle, and with that object in view,

action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the livestock owner. It is he who must take a very important part all through the campaign of tuberculosis eradication, and if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped whenever possible. After diseased animals are found and removed from the premises, a *very thorough* cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant. The use of disinfectants without first doing the necessary and proper cleaning is ineffective for the reason that the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences, can then be sprayed properly with the disinfectant.

All this means much work, but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where livestock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

DISPOSAL OF REACTORS

The disposal of reactors depends largely on the State laws and livestock regulations of the State in which the herd belongs. If the animals are purebred and registered and of unusual merit, they should be segregated, preferably on farms set aside by the State or by the purebred cattle associations, for the purpose of retaining tuberculous cattle in quarantine. If the condemned animals are grade cattle, or purebreds not specially valuable for breeding, it will probably be more economical to have them slaughtered than to hold them in quarantine. Of course the fact is recognized that in States and communities where tuberculosis exists extensively the slaughtering of all reactors is impracticable. In such instances the infection can be reduced on all the farms by keeping the tuberculous animals separate from the healthy ones. The tuberculous cattle are kept under quarantine restrictions until no longer profitable; meanwhile the healthy animals are safe from the danger of infection.

TABLE 4.—*Progress of cooperative tuberculin testing 1917–1928*

Fiscal year	Herds tested	Cattle tested	Reactors found	Per cent reactors
1917		20,101	645	3.2
1918		134,143	6,544	4.9
1919		329,878	13,528	4.1
1920	40,348	700,670	28,709	4.1
1921	86,687	1,366,358	53,768	3.9
1922	195,220	2,384,236	82,569	3.5
1923	296,138	3,460,849	113,844	3.3
1924	455,034	5,312,364	171,559	3.2
1925	607,345	7,000,028	214,491	3.1
1926	774,728	8,650,780	323,084	3.7
1927	871,561	9,700,176	285,361	2.9
1928	1,048,277	11,281,490	262,113	2.3

MARKING ANIMALS FOR IDENTIFICATION

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified. One method that is quite generally used is that of branding; a letter "T" about 2 inches high is branded on the left lower jaw. In addition to the branding, the reacting animals should be properly tagged so that each one may be positively identified, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is usually placed in the left ear of the animal and contains a serial number as well as the word "Reactor."

The marking of cattle that have passed the tuberculin test is a matter that is being handled in different ways throughout the United States, and it is believed that the present methods of marking will be improved. In some cases a metal ear tag is used and in others certain marks of identification are tattooed in the ear. Tattooing has an advantage over the tagging in being less expensive and probably more permanent.

It is not often necessary to require special marks on purebred registered cattle, as the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking to show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine to show the origin of those found to be tuberculous on post-mortem examination consists in tattooing a number or mark of identification into the skin of the hog. The method is fully described in Miscellaneous Circular 57, "The Tattoo Method of Marking Hogs and Its Use."

Many shipments which contain tuberculous swine are traced back to the farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised efforts can be directed in eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY

In addition to the various benefits derived from eradicating tuberculosis provision for the appraisement of diseased cattle with indemnity for those slaughtered is a further incentive. Federal legisla-

tion and supplementary laws in numerous States now divide the burden of loss, so that the Government, the State, and the owner of the cattle all bear a share of it. Briefly, the Federal law provides that the Secretary of Agriculture may reimburse, in part, owners of animals destroyed on account of tuberculosis in cooperation with States, counties, and municipalities. The bases upon which Federal indemnities are paid are:

1. No payment shall exceed one-third of the difference between the appraised value of such animal and the salvage value.
2. No payment shall exceed the amount paid or to be paid by the State, county, or municipality.
3. In no case shall any payment be more than $25 for any grade animal or more than $50 for any purebred animal.
4. No payment shall be made unless the owner has complied with all lawful quarantine regulations.

Legislation regarding indemnities for tuberculous cattle varies somewhat in different States, and for detailed and current information on the subject the reader is referred to his State livestock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained by addressing the Bureau of Animal Industry, U. S. Department of Agriculture.

A careful study of Figures 5, 7, 8, and 9 in this bulletin will enable the reader to become familiar with the appearance of the parts of the body most commonly affected. He will also see, even more clearly than can be described, that a real danger exists in permitting diseased animals or those of doubtful health to mingle with others. The illustrations of the accredited herds, on the other hand, show the splendid types of cattle which their owners have subjected to the tuberculin test and which have passed it successfully.

XUM

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October 10, 1928

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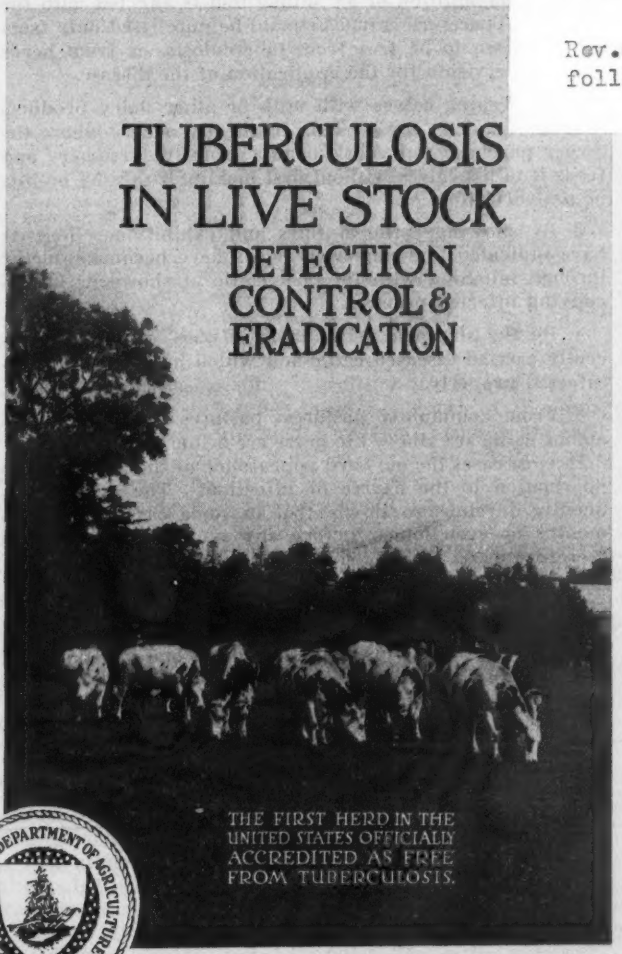
TUBERCULOSIS IN LIVE STOCK

DETECTION CONTROL & ERADICATION



XUM

HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

1. By the addition of an animal that is affected with the disease. Therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

2. By feeding calves with milk or other dairy products from tuberculous cows. This frequently occurs where the owner purchases mixed skim milk from the creamery and feeds it to his calves without first making it safe by boiling or pasteurization.

3. By showing cattle at fairs and exhibitions. Reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

4. By the shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

5. From community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

COOPERATIVE WORK FOR TUBERCULOSIS ERADICATION

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the United States Department of Agriculture, the livestock sanitary officials of the various States, and individual cattle owners.

Washington, D. C.

Issued November, 1919
Revised October, 1929

TUBERCULOSIS IN LIVESTOCK

DETECTION, CONTROL, AND ERADICATION

By JOHN A. KIERNAN,[1] *Chief*, and ALEXANDER E. WIGHT, *Assistant Chief*, *Tuberculosis Eradication Division, Bureau of Animal Industry*

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PRESENT KNOWLEDGE OF TUBERCULOSIS

PROBABLY no disease affecting either the human race or livestock is better known or has been the object of so much study as tuberculosis. Present knowledge of the disease is derived from many sources, including the work of eminent scientists who discovered its cause, and studies of the numerous ways in which it is spread, of the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1890 by the eminent scientist, Dr. Robert Koch. Thus the test has been known for more than a third of a century. The facts regarding it and other information presented in this bulletin are based on long experience and results verified many times. The methods recommended to be used in the eradication of tuberculosis have been tried on large numbers of herds and found to be effectual and practicable.

EARLY ERADICATION IS MOST ECONOMICAL

Livestock owners are earnestly requested not to wait until State and Federal officers come into their localities to eradicate tuberculosis. In almost every locality of the United States are veterinarians capable of rendering valuable services to livestock owners in this great work, and the cost of eradicating is greatly reduced by combating the disease in its early stages. Yet even in badly affected herds eradication can be undertaken with success. There

[1] Doctor Kiernan died in December, 1927, and Doctor Wight became chief of division on Jan. 1, 1928.

are records of many herds, in which three-fourths of the animals were affected with tuberculosis, which eventually were freed from it and afterwards maintained in a healthy condition.

Numerous economic advantages that are being derived by the livestock industry as a result of the eradication work have been reported to the department. Among them may be mentioned the fact that the measures taken to clean up tuberculosis from a herd lead to increased productivity and improved methods of management. Other advantages are increased prices received for surplus breeding cattle as well as for cast-off animals that are disposed of for beef. Direct benefits are reported also in the form of premiums paid by packers for swine from modified accredited areas.

FIG. 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. On application of the tuberculin test, 37, or 82 per cent, of the animals were found to be tuberculous. The germs of the disease may live for months in manure or litter

The extirpation of tuberculosis from livestock is important not only from an economic standpoint, but also because a considerable percentage of tuberculosis in the human family, especially among children, is positively due to the consumption of infected milk or other dairy products from tuberculous cows. It is eminently proper for the respective State governments to expend funds for the maintenance of tuberculosis sanitariums for the care of persons afflicted with that disease, and likewise it is extremely important to use vigorous measures to check the marketing of germ-laden milk. While it is true that proper pasteurization of milk destroys the living organisms of tuberculosis, a large part of the milk consumed daily is not pasteurized, and some of the milk so treated is not always made entirely safe.

TUBERCULOSIS A DECEPTIVE DISEASE

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among the livestock owners, who would insist upon its immediate eradication; but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals (see fig. 1), many people believe that it does comparatively little damage among livestock. Contrary to such opinions, however, the loss from tuberculosis is one of the heaviest taxes imposed upon our livestock industry, amounting, probably, to at least $40,000,000 a year in the United States.

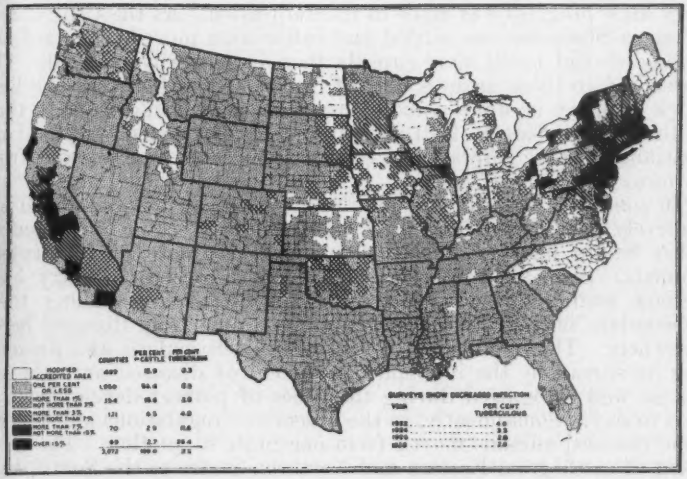

FIG. 2.—Extent of bovine tuberculosis in the United States, May 1, 1928

PREVALENCE OF TUBERCULOSIS

In every State and Territory in the Union there is some tuberculosis among cattle and swine, though the degree varies considerably. An estimate of the extent of bovine tuberculosis is given in Table 1 and shown graphically in Figure 2.

TABLE 1.—*Estimated percentage of bovine tuberculosis in the United States (calculated to May 1, 1928)*

Extent of infection	Area affected				Cattle in area	Degree of infection (per cent of reactors)
	Counties	*Per cent*	*Square miles*	*Per cent*	*Per cent*	
Modified accredited area (0.5 per cent or less by actual test)	499	16.2	373,178	12.6	15.9	0.3
0 to 1 per cent	1,959	63.8	2,094,432	70.5	56.4	.5
Over 1 to 3 per cent	354	11.5	290,510	9.8	15.6	2.0
Over 3 to 7 per cent	121	3.9	107,056	3.6	6.5	4.8
Over 7 to 15 per cent	70	2.3	59,427	2.0	2.9	11.6
Over 15 per cent	69	2.3	45,007	1.5	2.7	26.4
Total or average	3,072	100.0	2,969,610	100.0	100.0	2.0

Tuberculosis is known to exist also quite extensively among cattle and swine in all the European countries; in fact, no part of the world is known to be absolutely free from it. There are, however, some restricted regions where its presence is not known or it exists to but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States tuberculosis among livestock in those regions was unknown so far as we know. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but livestock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the livestock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

In some localities in the West where dairying has developed extensively it is now known that carload lots of cows purchased in other States have contained 50 per cent or more of tuberculous animals. Some herds of beef cattle in our western country have become contaminated with the disease by placing among them tuberculous purebred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is to-day. Consequently, in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick. Therefore there is probably less tuberculosis among the herds of the Southern States than in any other part of the Nation. This favorable condition should be taken advantage of, for in all probability the livestock industry will reach a high development in that area in future years. It is especially important that the herds of the Southern States be protected by permitting only tuberculosis-free animals to enter.

LOSSES OF MEAT FOOD PRODUCTS

Records kept by the Meat Inspection Division of the Bureau of Animal Industry show the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 per cent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 per cent of these classes of animals slaughtered each year in the United States do not appear in these

records. It is probable also that the percentage of tuberculosis is greater in the uninspected animals. In view of these considerations the losses shown in Table 2 are believed to be considerably less than the total loss throughout the country.

TABLE 2.—*Number of cattle and swine slaughtered, and those retained and condemned on account of tuberculosis, at establishments where Federal meat inspection is maintained*

Fiscal year	Cattle			Swine		
	Slaughtered	Retained [1]	Condemned	Slaughtered	Retained [1]	Condemned
1907 [2]	5, 867, 642	24, 876	17, 117	26, 189, 026	362, 445	48, 544
1908	7, 116, 275	68, 395	24, 371	35, 113, 077	719, 279	77, 554
1909	7, 325, 337	100, 650	24, 525	35, 427, 931	860, 425	45, 113
1910	7, 962, 189	123, 501	27, 638	27, 656, 021	792, 176	28, 880
1911	7, 781, 030	133, 551	27, 186	29, 916, 363	1, 117, 789	31, 517
1912	7, 532, 005	160, 122	35, 273	34, 966, 378	1, 643, 100	42, 267
1913	7, 155, 839	152, 560	33, 001	32, 287, 538	1, 809, 751	47, 632
1914	6, 724, 117	143, 699	29, 738	33, 289, 705	2, 201, 005	48, 252
1915	6, 964, 502	158, 239	32, 644	36, 247, 858	2, 774, 835	66, 023
1916	7, 404, 288	190, 991	37, 085	40, 482, 799	3, 687, 817	74, 109
1917	9, 299, 489	218, 928	46, 351	40, 210, 847	3, 978, 168	76, 807
1918	10, 938, 287	222, 787	40, 692	35, 449, 247	3, 494, 587	59, 740
1919	11, 241, 991	205, 698	37, 600	44, 398, 389	4, 103, 376	65, 837
1920	9, 709, 819	200, 647	37, 492	38, 981, 914	4, 260, 719	65, 609
1921	8, 179, 572	173, 658	33, 328	37, 702, 866	4, 693, 305	64, 830
1922	7, 871, 457	213, 606	39, 434	39, 416, 439	5, 640, 081	70, 304
1923	9, 029, 536	251, 299	49, 839	48, 600, 069	7, 139, 925	88, 688
1924	9, 188, 652	280, 905	56, 760	54, 416, 481	8, 293, 965	100, 110
1925	9, 773, 883	322, 925	61, 104	48, 459, 608	7, 039, 724	86, 282
1926	10, 098, 121	419, 028	70, 604	40, 442, 730	5, 667, 093	63, 748
1927	10, 049, 589	351, 716	53, 512	42, 650, 443	5, 778, 009	59, 656
1928	9, 040, 028	294, 002	38, 931	48, 347, 393	5, 872, 503	55, 749
1929	8, 284, 324	244, 608	31, 254	47, 163, 573	5, 408, 910	46, 624

[1] Held for more complete examination to determine final disposal.
[2] Covers 9 months from Oct. 1, 1906, to June 30, 1907.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is placed aside for further examination. If the disease is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed and the remainder is passed. It will be noted that such is the case in most carcasses retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In the animals that are retained and when the disease is not extensive enough to cause condemnation of the entire carcass the disease is in most cases in the early stages. Had the animals been allowed to live for possibly only a short time longer the disease would have progressed until all the carcass would have to be considered diseased. In others the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and endanger healthy cattle and swine.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of

diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from that farm.

CAUSE OF TUBERCULOSIS

The direct and primary cause of tuberculosis is a rod-shaped germ which can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or livestock is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures,

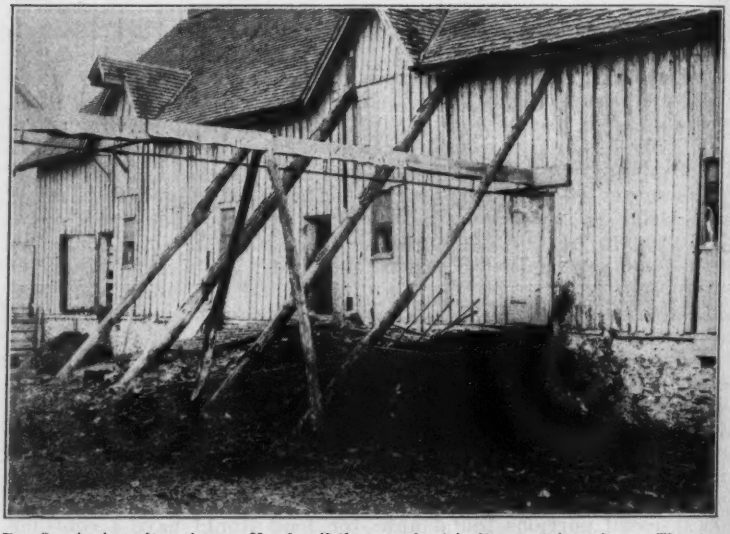

FIG. 3.—An insanitary barn. Nearly all the cows kept in it were tuberculous. The stone foundation wall retained about 2 feet of liquid manure which contained millions of tubercle germs. Premises of this character can not be kept sanitary

paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other inclosures which have contained tuberculous animals, before healthy ones are again placed in them.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuber-

culosis among the stock whenever the germs are present. (See figs. 3 and 4.) Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket that the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED

The tuberculous cow is the greatest source of danger to healthy cattle, and inasmuch as it can not be determined just when that animal becomes a "spreader" of the germs unless daily microscopic tests are made of the discharges from the body and the milk is also

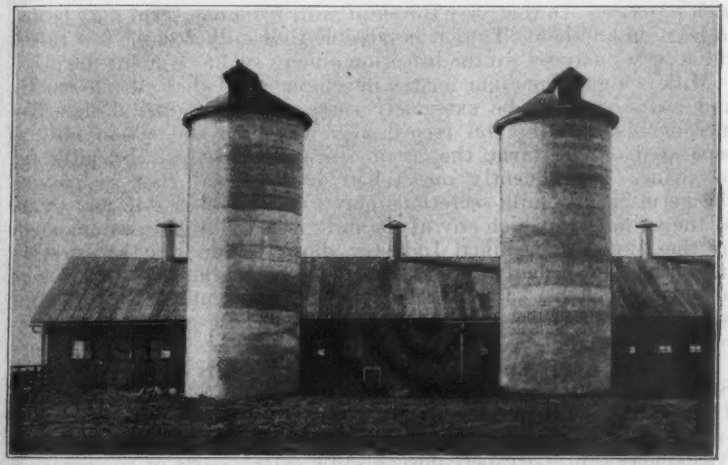

FIG. 4.—A modern sanitary barn. Note ventilators and liberal window space

examined microscopically, it is unsafe to keep it with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming into contact with affected animals than in any other way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

The continuous water trough in barns is also the cause to a very large extent of spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which infected milk or the washings from infected milk cans have been dumped may also be a source

of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected by drinking milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE BECOME INFECTED

The tuberculous cow is not only a menace to other cattle but is also the commonest source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the development of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record also in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are kept on the same farm, some of the latter are tuberculous. Eradication of tuberculosis from cattle, it is believed, will greatly reduce its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States, is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuberculosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another. Recent investigations indicate that a large percentage of hogs found to be slightly affected with tuberculosis have contracted the infection from poultry.[2]

SYMPTOMS OF TUBERCULOSIS

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms. (See fig. 1.) Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When

[2] Farmers' Bulletin 1200 describes and gives information on fowl tuberculosis.

tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening, as shown in Figure 5. Animals affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an animal are affected it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased

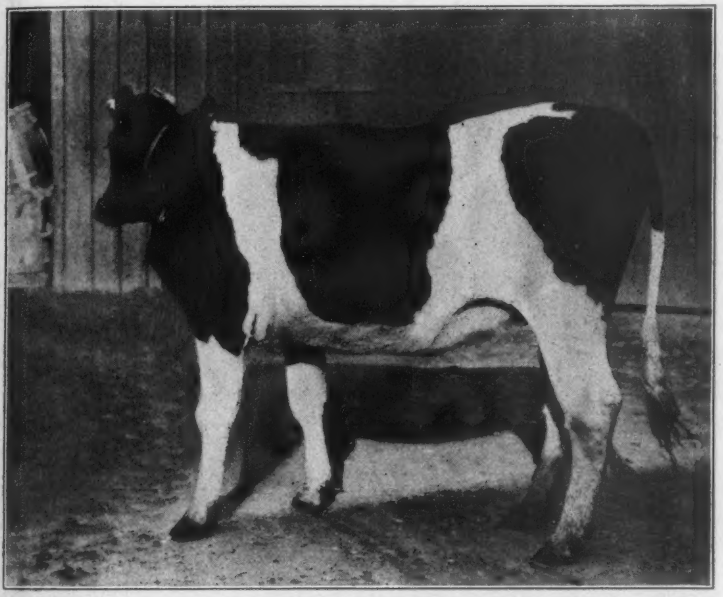

FIG. 5.—A tuberculous heifer. The gland at the shoulder was diseased and discharging tuberculous pus

respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased the animal often develops bloat (fig. 6). Diarrhea is often evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

METHODS OF DIAGNOSIS

Microscopic examinations of sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of

experience the tuberculin test is now considered to be the most practicable and satisfactory way of discovering the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

THE TUBERCULIN TEST

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-

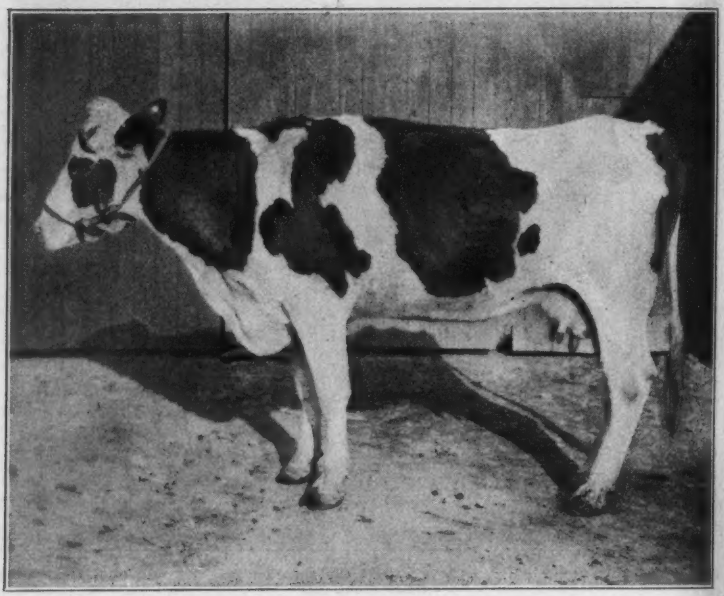

FIG. 6.—A reacting cow that was constantly "bloating." The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating

known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and in the hands of skillful persons, it is a reliable agent for detecting tuberculosis in animals. It contains no tubercle bacilli but is a product of the growth of tubercle bacilli properly mixed with a substance on which it has grown and properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used.

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action.

Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to its application at another time; therefore it may be misused by unscrupulous persons.

THE SUBCUTANEOUS TEST (UNDER THE SKIN)

The subcutaneous test is made by injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to measure the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are measured at least three times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the person who applies the test, and a careful observance of any clinical changes is always important in determining the result. It can not be set forth too strongly that the test, including the two following methods, should be attempted only by those who are properly qualified to do the work.

THE INTRADERMIC TEST (INTO THE SKIN)

The intradermic test for detecting tuberculosis is used extensively. When made by those who have become skilled in its application it is very accurate. In this test the tuberculin is injected between the layers of the skin, only a few drops being used, and it is usually applied in the region at the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine, and when so used the tuberculin is applied into the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is usually observed from 72 to 120 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced person.

THE OPHTHALMIC TEST (INTO THE EYE)

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the previously described methods. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the

fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit.

In all cases the tests, used either alone or in combination, should be applied by capable persons familiar with tuberculin testing.

POST-MORTEM APPEARANCES

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs. The lesions are of various sizes and may contain pus, either soft or hard; many times it is gritty. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities. Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands, to some extent, are usually affected, and, when cut into, show diseased areas characteristic of tuberculosis.

FIG. 7.—Part of a tuberculous udder showing well-developed lesions

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible for even a person skilled in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals that reacted to the test were not affected with tuberculosis to some extent, even though some were very slight.

Characteristic lesions of bovine tuberculosis are shown in Figures 7, 8, and 9.

METHODS OF ERADICATION

Cattle owners who do not know whether tuberculosis exists among their animals should ascertain the fact by having them tuberculin tested and physically examined by a qualified veterinarian. In

many cases thousands of dollars and very valuable breeding animals might have been saved by taking up tuberculosis-eradication work in time.

Three main projects comprise the general campaign of eradication, as follows:

1. Eradication of tuberculosis from purebred herds of cattle.
2. Eradication of tuberculosis from circumscribed areas.
3. Eradication of tuberculosis from swine.

It is important to eradicate tuberculosis from purebred herds of cattle at the earliest possible date because the spread of the disease is greater among such animals than among grade cattle. The reason is not that purebreds are any more susceptible, but that they are shipped extensively to every part of the United States for

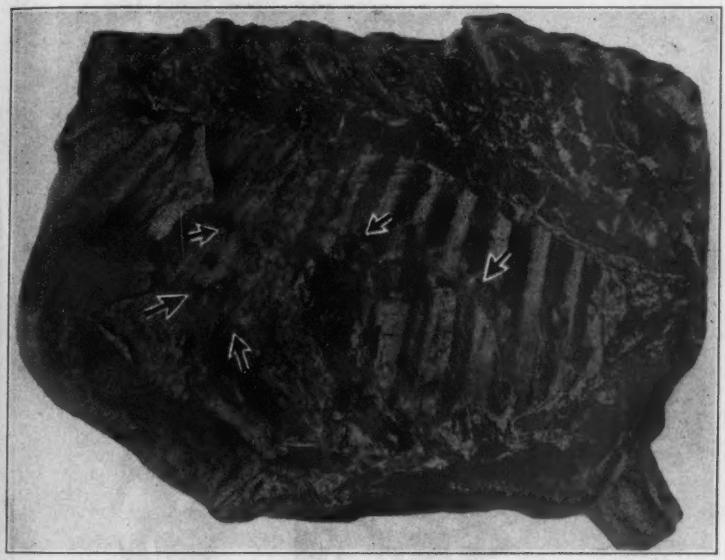

FIG. 8.—Beef carcass showing tuberculous nodules on ribs

breeding purposes. A purebred bull or cow may be shipped from Maine to Texas, or from the State of Washington to Florida. If it is diseased and is introduced into a healthy herd, it not only fails to fulfill the purpose for which it was intended—the upbreeding of the herd—but it actually causes heavy damage by spreading the disease to healthy animals. (See fig. 10.)

ACCREDITED-HERD OR HONOR-ROLL PLAN

The breeders of purebred registered cattle fully appreciated the above-mentioned fact when, together with the livestock sanitary officials of practically all the States, they adopted what is known as the accredited-herd plan, the principles of which are that herds found to be free from tuberculosis on two successive annual tests

are placed on the honor roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of one year. This plan is becoming well known to breeders throughout the United States.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for purebreds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly

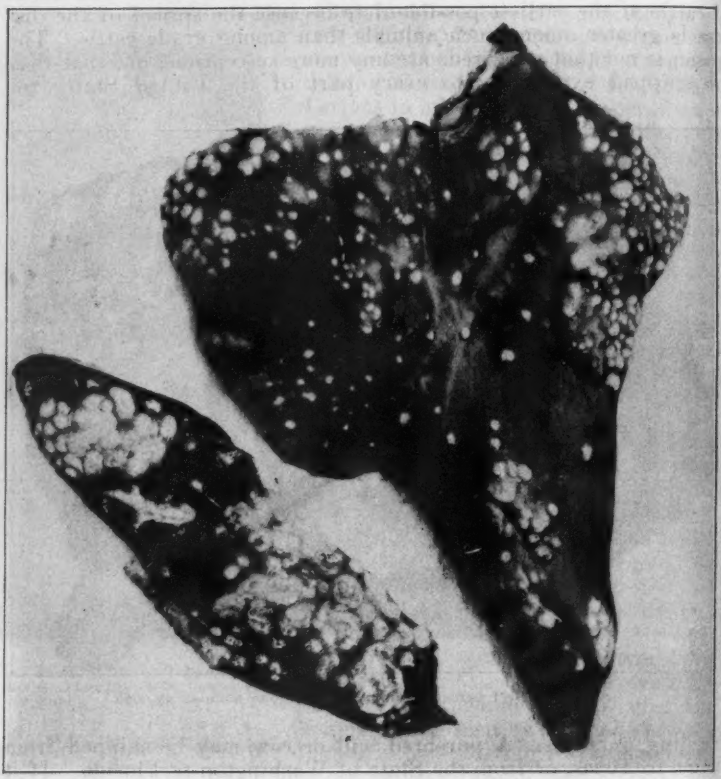

FIG. 9.—Liver and spleen showing extensive lesions of tuberculosis

tuberculin tested. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

ERADICATION FROM AREAS

As a general plan, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county should pay (1) part of the expense of extermi-

nating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it is advisable to clean up the herds within a township or possibly one-third or one-half of the area. The progress depends upon the degree of infection found and the cooperation furnished by the owners.

FIG. 10.—How a herd may become reinfected with tuberculosis. This herd was free from tuberculosis for a number of years. During 1917, 4 cattle were purchased in another State and placed in the herd without proper tuberculin test. When official test was made, December, 1917, 5 reactors were found. Three of the reactors were slaughtered and 2 kept in the herd. At the next test, January, 1919, 11 reactors and 2 suspects were in the herd of 28 cattle

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin tested; of the total number, 321 cattle, or 18.87 per cent, were tuberculous. The reactors were removed from the herds and, in most instances, were slaughtered. The infected barns, sheds, and premises were cleaned and disinfected.

Each year since the inauguration of the campaign all the cattle have been tuberculin tested, with the result that the infection has almost disappeared.

The plan of carrying on eradication under the area plan is practicable and is being conducted in many States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make, it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The intradermic method should be used, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermic test, the entire herd should be tested within from 60 to 90 days, using the ophthalmic test as a check. General experience shows that it is sound practice, if there is any doubt, to use all three methods of testing with tuberculin. Such a policy is

FIG. 11.—This Hereford herd was free from tuberculosis within 3 years. The first test, in 1916, showed the herd to be 10 per cent tuberculous. The reactors were removed and in 1918 all the 62 animals in the herd were found to be healthy

especially applicable to cattle which have been tested frequently and among herds which are or have been extensively diseased.

When not more than one-half of 1 per cent of the cattle in a given area, usually a county, are found to be affected with tuberculosis, such area is declared to be a "modified accredited area." Cattle from such areas may be moved interstate without further tuberculin test. At several of the larger markets a premium of 10 cents a hundred pounds is paid for hogs from these areas. The first counties were accredited in July, 1923, and 740 counties had been accredited up to July 1, 1929. Eradication work under the area plan is in operation in approximately 460 additional counties.

ERADICATION FROM SWINE

With the gradual elimination of tuberculosis from cattle and poultry the disease among swine will grow correspondingly smaller. It

is not necessary to tuberculin test all the swine herds because, with the exception of valuable breeding animals, it is more economical to slaughter the diseased ones when fat than to undertake to exterminate the disease in any other way.

In the case of suspected valuable purebred swine, their freedom from tuberculosis can be determined definitely by the intradermic method, which is practicable and reliable.

The injection made is near the base of the left ear; the other ear acts as a check for comparison. A reaction is manifested by a

FIG. 12.—An accredited Jersey herd in Minnesota

swelling in the region where the tuberculin was injected. The swelling may appear any time from the 24th to the 104th hour after injection and will remain for several days. As in the case of cattle, diseased swine should be removed from the farm, and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

PROGRESS OF ERADICATION

The campaign for the systematic eradication of tuberculosis from livestock has met with increasing favor. Applications for testing are far in excess of the capacity of the available forces and appropriations, and there is always a waiting list of herd owners desiring to have their cattle tested. Tables 3 and 4 show the progress made.

TABLE 3.—*Status of cooperative tuberculosis-eradication work, including all herds under supervision July 1, 1929*

State	Modified-accredited counties	Passed one test		Accredited		Under supervision	
		Herds	Cattle	Herds	Cattle	Herds	Cattle
Alabama		5,598	53,897	305	16,388	8,191	79,181
Arizona		2,243	99,264	45	2,570	8,319	101,766
Arkansas	1	2,893	12,345	17	747	9,126	33,643
California	2	6,580	226,363	117	8,886	6,749	298,982
Colorado		947	14,493	165	4,463	1,450	26,482
Connecticut		3,761	18,728	2,586	44,919	7,042	74,457
Delaware		3,509	13,330	2,094	10,385	6,380	27,630
District of Columbia		99	545	8	332	107	901
Florida		7,901	88,723	202	9,352	8,734	132,790
Georgia	10	25,463	109,307	27	2,045	25,496	111,477
Idaho	27	33,468	367,820	56	2,004	36,693	417,074
Illinois	43	142,547	987,090	5,384	50,904	160,516	1,388,480
Indiana	64	126,689	814,227	27,875	235,475	173,721	1,093,215
Iowa	44	105,640	1,466,537	3,157	76,866	172,700	2,904,570
Kansas	41	82,717	864,821	836	25,180	84,094	900,041
Kentucky	18	71,564	489,223	60	2,538	73,378	511,440
Louisiana		8,080	81,359	17	1,040	8,450	91,742
Maine	16	43,008	224,705	699	12,794	43,817	238,761
Maryland	1	15,127	84,648	7,153	86,326	28,285	200,930
Massachusetts	1	2,084	17,213	1,390	21,641	4,191	48,311
Michigan	65	166,890	1,338,552	72	3,835	169,654	1,353,493
Minnesota	24	79,388	1,280,210	9,142	184,761	92,496	1,542,481
Mississippi	5	5,205	106,306	27	1,589	5,232	107,895
Missouri	9	71,686	622,376	227	9,365	75,377	678,219
Montana	[1] 11	31,429	311,561	91	6,186	31,897	556,010
Nebraska	37	67,210	841,153	105	4,783	67,566	851,535
Nevada		1,235	20,094	11	759	1,546	38,279
New Hampshire	1	2,059	22,541	3,942	49,213	6,123	72,888
New Jersey		3,915	12,221	2,829	13,400	9,876	37,219
New Mexico		2,051	17,081	23	1,935	2,132	19,257
New York	8	27,049	248,165	68,138	651,324	105,371	1,039,974
North Carolina	100	256,530	668,622	394	12,703	257,311	683,257
North Dakota	26	52,394	822,427	5,149	104,356	63,667	1,067,570
Ohio	35	174,315	1,096,774	543	11,275	181,092	1,282,844
Oklahoma		129	5,746	288	10,871	440	17,960
Oregon	7	50,970	357,870	465	10,240	51,457	368,252
Pennsylvania	20	105,350	564,580	5,302	95,599	123,598	915,928
Rhode Island		170	1,485	101	2,014	419	5,653
South Carolina	12	59,380	166,963	102	3,851	59,546	172,517
South Dakota	5	8,687	153,401	1,256	29,587	10,137	198,222
Tennessee	11	62,028	277,940	169	7,638	62,328	290,938
Texas		553	9,249	248	9,883	912	28,637
Utah	1	10,724	65,647	99	2,908	11,563	93,422
Vermont	[2]	5,495	57,770	6,844	125,283	22,343	212,873
Virginia	25	20,639	95,079	1,277	30,732	22,187	137,469
Washington	[3] 9	41,589	367,562	86	4,076	45,300	472,266
West Virginia	18	48,248	205,692	1,190	15,525	50,052	240,690
Wisconsin	43	149,349	2,315,055	10,678	261,173	163,688	2,659,916
Wyoming		9,948	113,732	4	294	11,306	130,016
Alaska							
Total	740	2,210,533	18,200,492	170,995	2,280,043	2,572,055	23,947,547

[1] Part of 1 county not included.
[2] 30 towns.
[3] Parts of 2 counties not included.

MEASURES OF PREVENTION

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regulating the movements of cattle, and with that object in view, action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the livestock owners. It is he who must take a very important part all through the campaign of tuberculosis eradication, and

if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped whenever possible. After diseased animals are found and removed from the premises, a *very thorough* cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant. The use of disinfectants without first doing the necessary and proper cleaning is ineffective for the reason that the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences, can then be sprayed properly with the disinfectant.

All this means much work, but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where livestock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

TABLE 4.—*Progress of cooperative tuberculin testing, 1917–1929*

Fiscal year	Herds tested	Cattle tested	Reactors found	Per cent reactors
1917		20,101	645	3.2
1918		134,143	6,544	4.9
1919		329,878	13,528	4.1
1920	40,348	700,670	28,709	4.1
1921	86,687	1,366,358	53,768	3.9
1922	195,220	2,384,236	82,569	3.5
1923	296,138	3,460,849	113,844	3.3
1924	455,034	5,312,364	171,559	3.2
1925	607,345	7,000,028	214,491	3.1
1926	774,728	8,650,780	323,084	3.7
1927	871,561	9,700,176	285,361	2.9
1928	1,048,277	11,281,490	262,113	2.3
1929	1,030,679	11,683,720	206,764	1.8

MARKING ANIMALS FOR IDENTIFICATION

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified. One method that is quite generally used is that of branding; a letter "T" about 2 inches high is branded on the left lower jaw. In addition to the branding, the reacting animals should be properly tagged so that each one may be positively identified, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is usually placed in the left ear of the animal and contains a serial number as well as the word "Reactor."

The marking of cattle that have passed the tuberculin test is a matter that is being handled in different ways throughout the United

States. In some cases a metal ear tag is used and in others certain marks of identification are tattooed in the ear. It is not often necessary to require special marks on purebred registered cattle, as the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking to show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine to show the origin of those found to be tuberculous on post-mortem examination consists in tattooing a number or mark of identification into the skin of the hog. The method is fully described in Miscellaneous Circular 57, "The Tattoo Method of Marking Hogs and Its Use."

Many shipments which contain tuberculous swine are traced back to the farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised, efforts can be directed in eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY

In addition to the various benefits derived from eradicating tuberculosis, provision for the appraisement of diseased cattle with idemnity for those slaughtered is a further incentive. Federal legislation and supplementary laws in numerous States now divide the burden of loss, so that the Government, the State, and the owner of the cattle all bear a share of it. Briefly, the Federal law provides that the Secretary of Agriculture may reimburse, in part, owners of animals destroyed on account of tuberculosis in cooperation with States, counties, and municipalities. The bases upon which Federal indemnities are paid are:

1. No payment shall exceed one-third of the difference between the appraised value of such animal and the salvage value.
2. No payment shall exceed the amount paid or to be paid by the State, county, or municipality.
3. In no case shall any payment be more than $35 for any grade animal or more than $70 for any purebred animal.
4. No payment shall be made unless the owner has complied with all lawful quarantine regulations.

Legislation regarding indemnities for tuberculous cattle varies somewhat in different States, and for detailed and current information on the subject the reader is referred to his State livestock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained by addressing the Bureau of Animal Industry, U. S. Department of Agriculture.

A careful study of Figures 5, 7, 8, and 9 in this bulletin will enable the reader to become familiar with the appearance of the parts of the body most commonly affected. He will also see, even more clearly than can be described, that a real danger exists in permitting diseased animals or those of doubtful health to mingle with others. The illustrations of the accredited herds, on the other hand, show the splendid types of cattle which their owners have subjected to the tuberculin test and which have passed it successfully.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

October 7, 1929

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This bulletin is a contribution from

Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Tuberculosis Eradication Division	A. E. WIGHT, *Chief.*

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FARMERS' BULLETIN No. 1069
Sept. 1930

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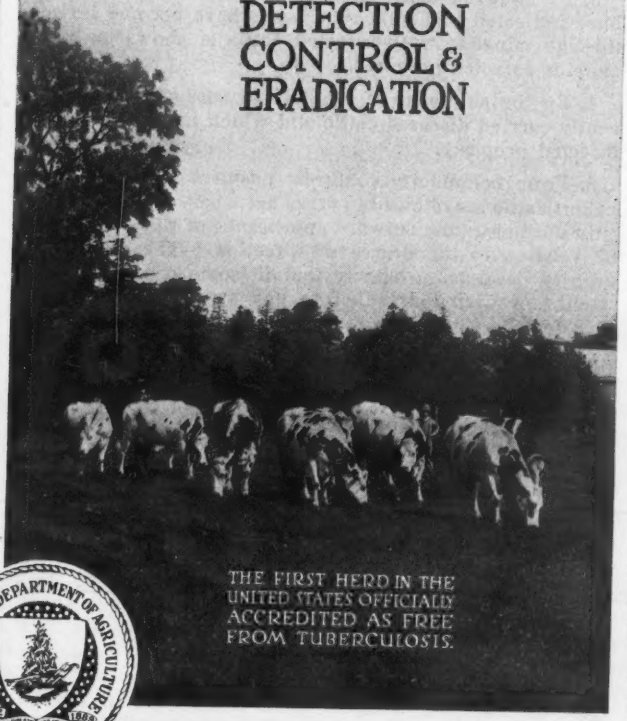
TUBERCULOSIS IN LIVE STOCK

DETECTION CONTROL & ERADICATION



THE FIRST HERD IN THE UNITED STATES OFFICIALLY ACCREDITED AS FREE FROM TUBERCULOSIS.

HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

1. By the addition of an animal that is affected with the disease. Therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

2. By feeding calves with milk or other dairy products from tuberculous cows. This frequently occurs where the owner purchases mixed skim milk from the creamery and feeds it to his calves without first making it safe by boiling or pasteurization.

3. By showing cattle at fairs and exhibitions. Reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

4. By the shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

5. From community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

COOPERATIVE WORK FOR TUBERCULOSIS ERADICATION

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the United States Department of Agriculture, the livestock sanitary officials of the various States, and individual cattle owners.

Washington, D. C.

Issued November, 1919
Revised September, 1930

TUBERCULOSIS IN LIVESTOCK

DETECTION, CONTROL, AND ERADICATION

By JOHN A. KIERNAN,[1] *Chief*, and ALEXANDER E. WIGHT, *Assistant Chief, Tuberculosis Eradication Division, Bureau of Animal Industry*

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PRESENT KNOWLEDGE OF TUBERCULOSIS

PROBABLY no disease affecting either the human race or livestock is better known or has been the object of so much study as tuberculosis. Present knowledge of the disease is derived from many sources, including the work of eminent scientists who discovered its cause, and studies of the numerous ways in which it is spread, of the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1890 by the eminent scientist, Dr. Robert Koch. Thus the test has been known for more than a third of a century. The facts regarding it and other information presented in this bulletin are based on long experience and results verified many times. The methods recommended to be used in the eradication of tuberculosis have been tried on large numbers of herds and found to be effectual and practicable.

EARLY ERADICATION IS MOST ECONOMICAL

Livestock owners are earnestly requested not to wait until State and Federal officers come into their localities to eradicate tuberculosis. In almost every locality of the United States are veterinarians capable of rendering valuable services to livestock owners in this great work, and the cost of eradicating is greatly reduced by combating the disease in its early stages. Yet even in badly affected herds eradication can be undertaken with success. There

[1] Doctor Kiernan died in December, 1927, and Doctor Wight became chief of division on Jan. 1, 1928.

are records of many herds, in which three-fourths of the animals were affected with tuberculosis, which eventually were freed from it and afterwards maintained in a healthy condition.

Numerous economic advantages that are being derived by the livestock industry as a result of the eradication work have been reported to the department. Among them may be mentioned the fact that the measures taken to clean up tuberculosis from a herd lead to increased productivity and improved methods of management. Other advantages are increased prices received for surplus breeding cattle as well as for cast-off animals that are disposed of for beef.

FIG. 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. On application of the tuberculin test, 37, or 82 per cent, of the animals were found to be tuberculous. The germs of the disease may live for months in manure or litter

The extirpation of tuberculosis from livestock is important not only from an economic standpoint, but also because a considerable percentage of tuberculosis in the human family, especially among children, is positively due to the consumption of infected milk or other dairy products from tuberculous cows. It is eminently proper for the respective State governments to expend funds for the maintenance of tuberculosis sanitariums for the care of persons afflicted with that disease, and likewise it is extremely important to use vigorous measures to check the marketing of germ-laden milk. While it is true that proper pasteurization of milk destroys the living organisms of tuberculosis, a large part of the milk consumed daily is not pasteurized, and some of the milk so treated is not always made entirely safe.

TUBERCULOSIS A DECEPTIVE DISEASE

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among the livestock owners, who would insist upon its immediate eradication; but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals (see fig. 1), many people believe that it does comparatively little damage among livestock. Contrary to such opinions, however, the loss from tuberculosis is one of the heaviest taxes imposed upon our livestock industry, amounting, probably, to at least $40 000,000 a year in the United States.

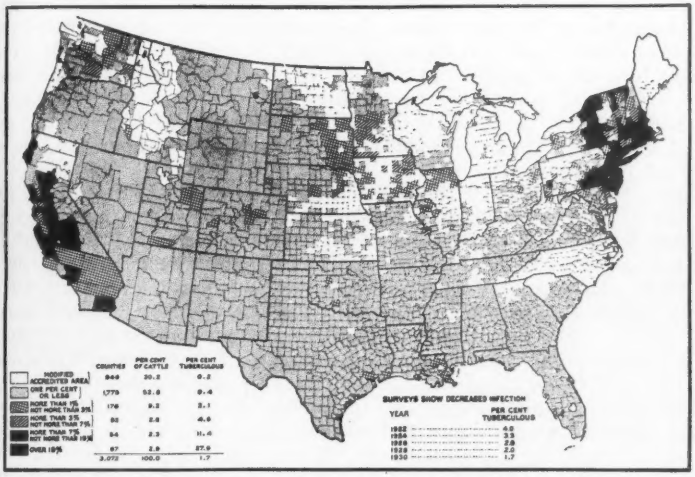

FIGURE 2.—Extent of bovine tuberculosis in the United States, May 1, 1930

PREVALENCE OF TUBERCULOSIS

In every State and Territory in the Union there is some tuberculosis among cattle and swine, though the degree varies considerably. An estimate of the extent of bovine tuberculosis is given in Table 1 and shown graphically in Figure 2.

TABLE 1.—*Estimated percentage of bovine tuberculosis in the United States (May 1, 1930)*

Extent of infection	Area affected				Cattle in area	Degree of infection (per cent reactors)
	Counties		Square miles			
	Number	*Per cent*	*Number*	*Per cent*	*Per cent*	
Modified accredited area (0.5 per cent or less by actual test)	946	30.8	686, 197	23.1	30.2	0.2
0 to 1 per cent	1, 775	57.7	1, 960, 765	65.9	52.8	.4
Over 1 to 3 per cent	178	5.8	181, 899	6.1	9.2	2.1
Over 3 to 7 per cent	52	1.7	38, 772	1.3	2.6	4.6
Over 7 to 15 per cent	54	1.8	62, 347	2.1	2.3	11.4
Over 15 per cent	67	2.2	43, 796	1.5	2.9	27.9
Total or average	3, 072	100.0	2, 973, 776	100.0	100.0	1.7

Tuberculosis is known to exist also quite extensively among cattle and swine in all the European countries; in fact, no part of the world is known to be absolutely free from it. There are, however, some restricted regions where its presence is not known or it exists to but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States tuberculosis among livestock in those regions was unknown so far as we know. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but livestock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the livestock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

In some localities in the West where dairying has developed extensively it is now known that carload lots of cows purchased in other States have contained 50 per cent or more of tuberculous animals. Some herds of beef cattle in our western country have become contaminated with the disease by placing among them tuberculous purebred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is to-day. Consequently, in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick. Therefore there is probably less tuberculosis among the herds of the Southern States than in any other part of the Nation. This favorable condition should be taken advantage of, for in all probability the livestock industry will reach a high development in that area in future years. It is especially important that the herds of the Southern States be protected by permitting only tuberculosis-free animals to enter.

LOSSES OF MEAT FOOD PRODUCTS

Records kept by the Meat Inspection Division of the Bureau of Animal Industry show the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 per cent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 per cent of these classes of animals slaughtered each year in the United States do not appear in these

records. It is probable also that the percentage of tuberculosis is greater in the uninspected animals. In view of these considerations the losses shown in Table 2 are believed to be considerably less than the total loss throughout the country.

TABLE 2.—*Number of cattle and swine slaughtered, and those retained and condemned on account of tuberculosis, at establishments where Federal meat inspection is maintained*

Fiscal year	Cattle			Swine		
	Slaughtered	Retained [1]	Condemned	Slaughtered	Retained [1]	Condemned
1907 [2]	5,867,642	24,876	17,117	26,189,026	362,445	48,544
1908	7,116,275	68,395	24,371	35,113,077	719,279	77,554
1909	7,325,337	100,650	24,525	35,427,931	860,425	45,113
1910	7,962,189	123,501	27,638	27,656,021	792,176	28,880
1911	7,781,030	133,551	27,186	29,916,363	1,117,789	31,517
1912	7,532,005	160,122	35,273	34,966,378	1,643,100	42,267
1913	7,155,839	152,560	33,001	32,287,538	1,809,751	47,632
1914	6,724,117	143,699	29,738	33,289,705	2,201,005	48,252
1915	6,964,502	158,239	32,644	36,247,858	2,774,835	66,023
1916	7,404,288	190,991	37,085	40,482,799	3,687,817	74,109
1917	9,299,489	218,928	46,351	40,210,847	3,978,168	76,807
1918	10,938,287	222,787	40,692	35,449,247	3,494,587	59,740
1919	11,241,991	205,698	37,600	44,398,389	4,103,376	65,837
1920	9,709,819	200,647	37,492	38,981,914	4,260,719	65,609
1921	8,179,572	173,658	33,328	37,702,866	4,693,305	64,830
1922	7,871,457	213,606	39,434	39,416,439	5,640,081	70,304
1923	9,029,536	251,299	49,839	48,600,069	7,139,925	88,688
1924	9,188,652	280,905	56,760	54,416,481	8,293,965	100,110
1925	9,773,883	322,925	61,104	48,459,608	7,039,724	86,282
1926	10,098,121	419,028	70,604	40,442,730	5,667,093	63,748
1927	10,049,589	351,716	53,512	42,650,443	5,778,009	59,656
1928	9,040,028	294,002	38,931	48,347,393	5,872,503	55,749
1929	8,284,324	244,608	31,254	47,163,573	5,408,910	46,624
1930	8,280,778	222,210	26,238	46,688,860	5,321,352	42,381

[1] Held for more complete examination to determine final disposal.
[2] Covers 9 months from Oct. 1, 1906, to June 30, 1907.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is placed aside for further examination. If the disease is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed and the remainder is passed. It will be noted that such is the case in most carcasses retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In the animals that are retained and when the disease is not extensive enough to cause condemnation of the entire carcass the disease is in most cases in the early stages. Had the animals been allowed to live for possibly only a short time longer the disease would have progressed until all the carcass would have to be considered diseased. In others the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and endanger healthy cattle and swine.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of

diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from that farm.

CAUSE OF TUBERCULOSIS

The direct and primary cause of tuberculosis is a rod-shaped germ which can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or livestock is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures,

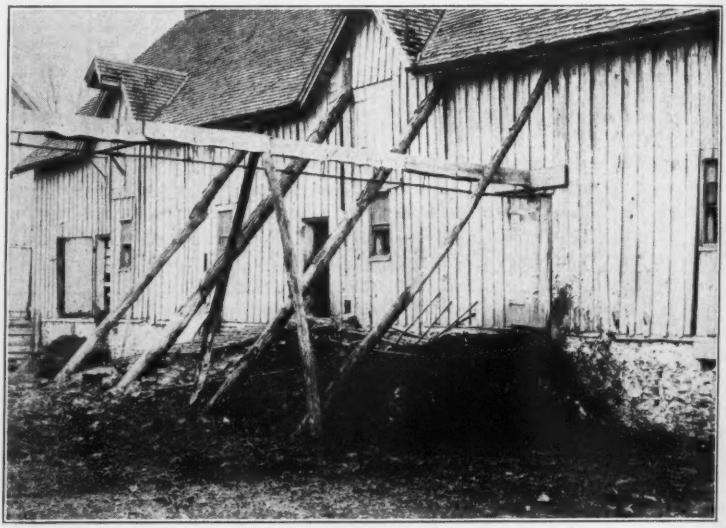

FIG. 3.—An insanitary barn. Nearly all the cows kept in it were tuberculous. The stone foundation wall retained about 2 feet of liquid manure which contained millions of tubercle germs. Premises of this character can not be kept sanitary

paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other inclosures which have contained tuberculous animals, before healthy ones are again placed in them.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuber-

culosis among the stock whenever the germs are present. (See figs. 3 and 4.) Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket that the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED

The tuberculous cow is the greatest source of danger to healthy cattle, and inasmuch as it can not be determined just when that animal becomes a "spreader" of the germs unless daily microscopic tests are made of the discharges from the body and the milk is also

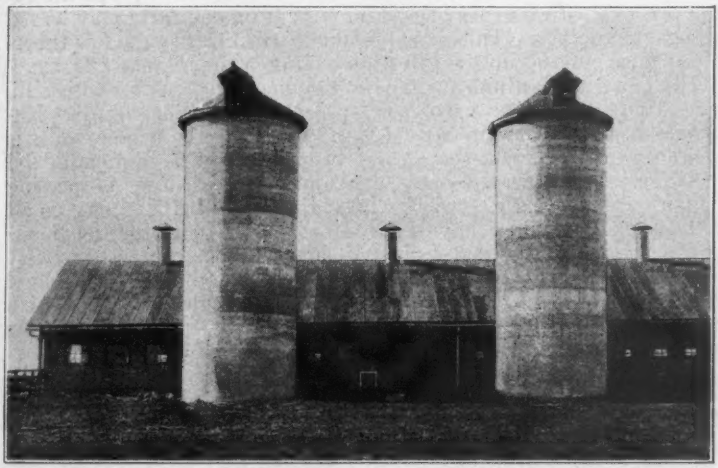

FIG. 4.—A modern sanitary barn. Note ventilators and liberal window space

examined microscopically, it is unsafe to keep it with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming into contact with affected animals than in any other way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

The continuous water trough in barns is also the cause to a very large extent of spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which infected milk or the washings from infected milk cans have been dumped may also be a source

of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected by drinking milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE BECOME INFECTED

The tuberculous cow is not only a menace to other cattle but is also the commonest source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the development of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record also in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are kept on the same farm, some of the latter are tuberculous. Eradication of tuberculosis from cattle, it is believed, will greatly reduce its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States, is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuberculosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another. Recent investigations indicate that a large percentage of hogs found to be slightly affected with tuberculosis have contracted the infection from poultry.[2]

SYMPTOMS OF TUBERCULOSIS

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms. (See fig. 1.) Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When

[2] Farmers' Bulletin 1200 describes and gives information on fowl tuberculosis.

tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening, as shown in Figure 5. Animals affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an animal are affected it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased

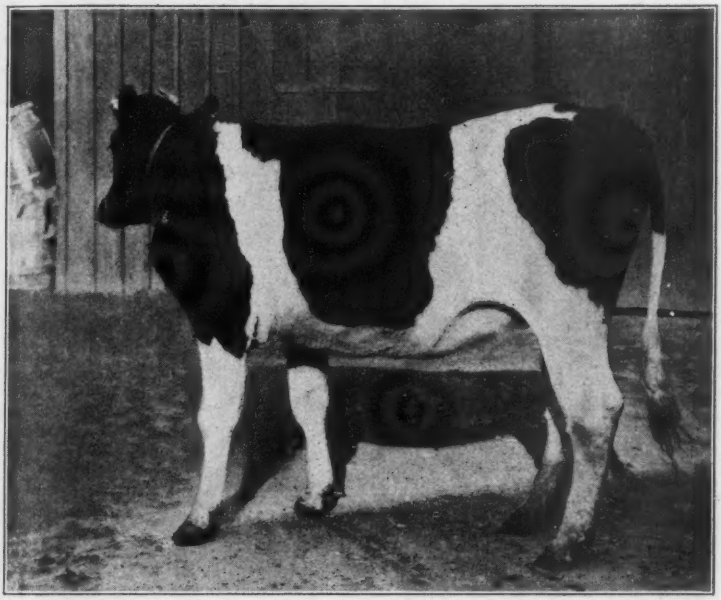

FIG. 5.—A tuberculous heifer. The gland at the shoulder was diseased and discharging tuberculous pus

respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased the animal often develops bloat (fig. 6). Diarrhea is often evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

METHODS OF DIAGNOSIS

Microscopic examinations of sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of

experience the tuberculin test is now considered to be the most practicable and satisfactory way of discovering the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

THE TUBERCULIN TEST

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-

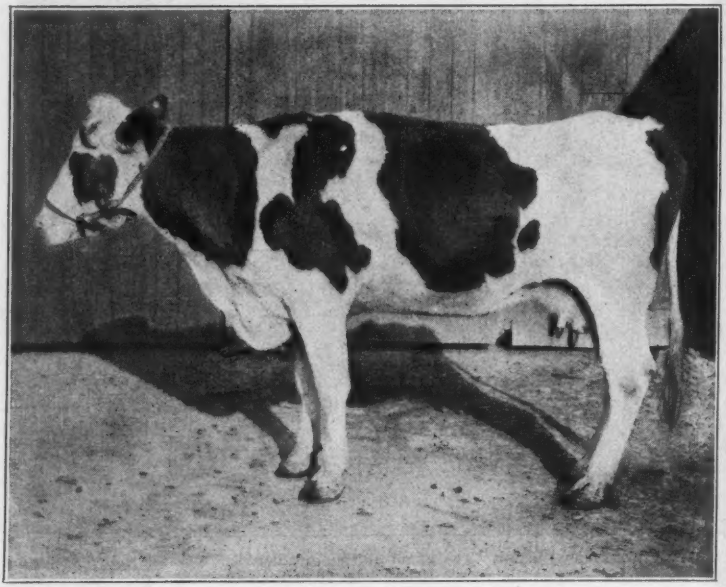

FIG. 6.—A reacting cow that was constantly "bloating." The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating

known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and in the hands of skillful persons, it is a reliable agent for detecting tuberculosis in animals. It contains no tubercle bacilli but is a product of the growth of tubercle bacilli properly mixed with a substance on which it has grown and properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used.

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action.

Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to its application at another time; therefore it may be misused by unscrupulous persons.

THE SUBCUTANEOUS TEST (UNDER THE SKIN)

The subcutaneous test is made by injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to measure the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are measured at least three times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the person who applies the test, and a careful observance of any clinical changes is always important in determining the result. It can not be set forth too strongly that the test, including the two following methods, should be attempted only by those who are properly qualified to do the work.

THE INTRADERMIC TEST (INTO THE SKIN)

The intradermic test for detecting tuberculosis is used extensively. When made by those who have become skilled in its application it is very accurate. In this test the tuberculin is injected between the layers of the skin, only a few drops being used, and it is usually applied in the region at the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine, and when so used the tuberculin is applied into the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is usually observed from 72 to 120 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced person.

THE OPHTHALMIC TEST (INTO THE EYE)

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the previously described methods. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the

fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit.

In all cases the tests, used either alone or in combination, should be applied by capable persons familiar with tuberculin testing.

POST-MORTEM APPEARANCES

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs. The lesions are of various sizes and may contain pus, either soft or hard; many times it is gritty. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities. Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands, to some extent, are usually affected, and, when cut into, show diseased areas characteristic of tuberculosis.

FIG. 7.—Part of a tuberculous udder showing well-developed lesions

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible for even a person skilled in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals that reacted to the test were not affected with tuberculosis to some extent, even though some were very slight.

Characteristic lesions of bovine tuberculosis are shown in Figures 7, 8, and 9.

METHODS OF ERADICATION

Cattle owners who do not know whether tuberculosis exists among their animals should ascertain the fact by having them tuberculin tested and physically examined by a qualified veterinarian. In

many cases thousands of dollars and very valuable breeding animals might have been saved by taking up tuberculosis-eradication work in time.

Three main projects comprise the general campaign of eradication, as follows:

1. Eradication of tuberculosis from purebred herds of cattle.
2. Eradication of tuberculosis from circumscribed areas.
3. Eradication of tuberculosis from swine.

It is important to eradicate tuberculosis from purebred herds of cattle at the earliest possible date because the spread of the disease is greater among such animals than among grade cattle. The reason is not that purebreds are any more susceptible, but that they are shipped extensively to every part of the United States for

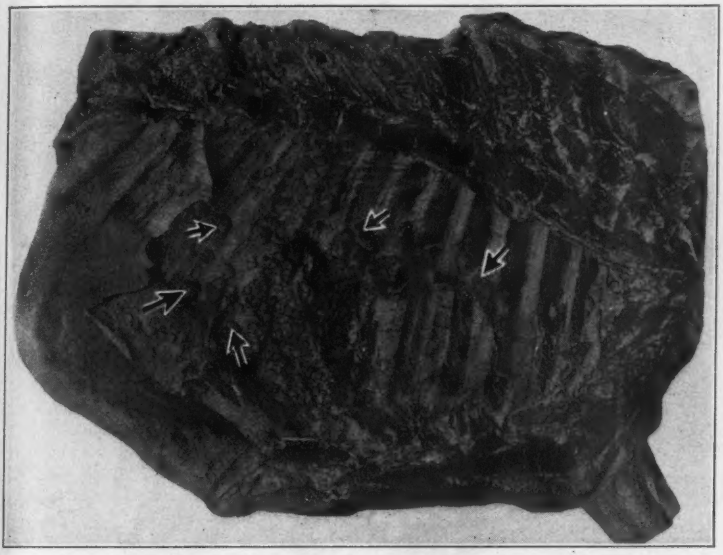

FIG. 8.—Beef carcass showing tuberculous nodules on ribs

breeding purposes. A purebred bull or cow may be shipped from Maine to Texas, or from the State of Washington to Florida. If it is diseased and is introduced into a healthy herd, it not only fails to fulfill the purpose for which it was intended—the upbreeding of the herd—but it actually causes heavy damage by spreading the disease to healthy animals. (See fig. 10.)

ACCREDITED-HERD OR HONOR-ROLL PLAN

The breeders of purebred registered cattle fully appreciated the above-mentioned fact when, together with the livestock sanitary officials of practically all the States, they adopted what is known as the accredited-herd plan, the principles of which are that herds found to be free from tuberculosis on two successive annual tests

are placed on the honor roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of one year. This plan is becoming well known to breeders throughout the United States.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for purebreds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly

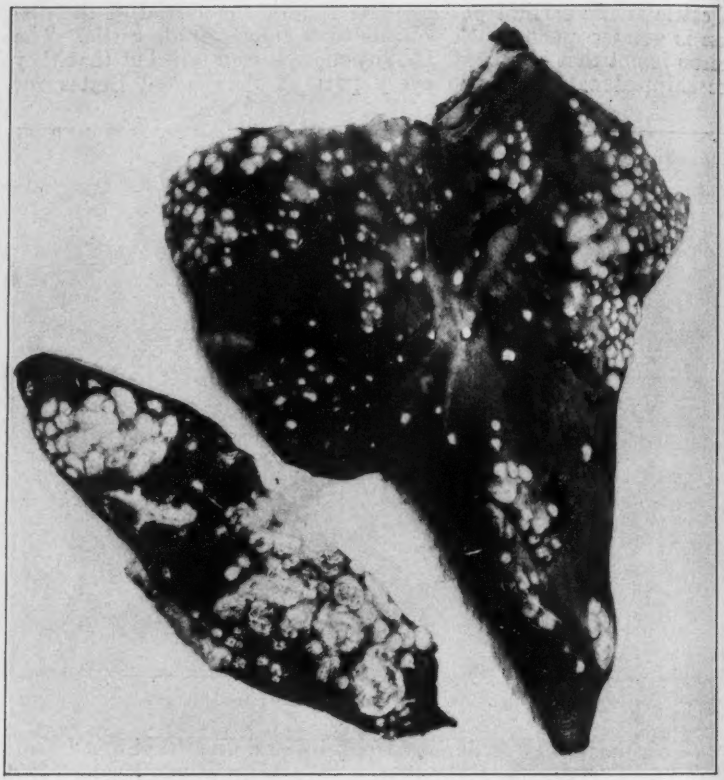

FIG. 9.—Liver and spleen showing extensive lesions of tuberculosis

tuberculin tested. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

ERADICATION FROM AREAS

As a general plan, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county should pay (1) part of the expense of extermi-

nating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it is advisable to clean up the herds within a township or possibly one-third or one-half of the area. The progress depends upon the degree of infection found and the cooperation furnished by the owners.

FIG. 10.—How a herd may become reinfected with tuberculosis. This herd was free from tuberculosis for a number of years. During 1917, 4 cattle were purchased in another State and placed in the herd without proper tuberculin test. When official test was made, December, 1917, 5 reactors were found. Three of the reactors were slaughtered and 2 kept in the herd. At the next test, January, 1919, 11 reactors and 2 suspects were in the herd of 28 cattle

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin tested; of the total number, 321 cattle, or 18.87 per cent, were tuberculous. The reactors were removed from the herds and, in most instances, were slaughtered. The infected barns, sheds, and premises were cleaned and disinfected.

Each year since the inauguration of the campaign all the cattle have been tuberculin tested, with the result that the infection has almost disappeared.

XUM

The plan of carrying on eradication under the area plan is practicable and is being conducted in many States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make, it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The intradermic method should be used, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermic test, the entire herd should be tested within from 60 to 90 days, using the ophthalmic test as a check. General experience shows that it is sound practice, if there is any doubt, to use all three methods of testing with tuberculin. Such a policy is

FIG. 11.—This Hereford herd was free from tuberculosis within 3 years. The first test, in 1916, showed the herd to be 10 per cent tuberculous. The reactors were removed and in 1918 all the 62 animals in the herd were found to be healthy

especially applicable to cattle which have been tested frequently and among herds which are or have been extensively diseased.

When not more than one-half of 1 per cent of the cattle in a given area, usually a county, are found to be affected with tuberculosis, such area is declared to be a "modified accredited area." Cattle from such areas may be moved interstate without further tuberculin test. At several of the larger markets a premium of 10 cents a hundred pounds is paid for hogs from these areas. The first counties were accredited in July, 1923, and 976 counties had been accredited up to July 1, 1930. Eradication work under the area plan is in operation in approximately 437 additional counties.

ERADICATION FROM SWINE

With the gradual elimination of tuberculosis from cattle and poultry the disease among swine will grow correspondingly smaller. It

is not necessary to tuberculin test all the swine herds because, with the exception of valuable breeding animals, it is more economical to slaughter the diseased ones when fat than to undertake to exterminate the disease in any other way.

In the case of suspected valuable purebred swine, their freedom from tuberculosis can be determined definitely by the intradermic method, which is practicable and reliable.

The injection made is near the base of the left ear; the other ear acts as a check for comparison. A reaction is manifested by a

FIG. 12.—An accredited Jersey herd in Minnesota

swelling in the region where the tuberculin was injected. The swelling may appear any time from the 24th to the 104th hour after injection and will remain for several days. As in the case of cattle, diseased swine should be removed from the farm, and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

PROGRESS OF ERADICATION

The campaign for the systematic eradication of tuberculosis from livestock has met with increasing favor. Applications for testing are far in excess of the capacity of the available forces and appropriations, and there is always a waiting list of herd owners desiring to have their cattle tested. Tables 3 and 4 show the progress made.

XUM

TABLE 3.—*Status of cooperative tuberculosis-eradication work, including all herds under supervision July 1, 1930*

State	Modified accredited counties	Passed 1 test		Accredited		Under supervision	
		Herds	Cattle	Herds	Cattle	Herds	Cattle
Alabama	0	10,970	83,827	317	16,746	13,557	109,753
Arizona	0	8,557	103,256	46	2,691	8,653	106,138
Arkansas	1	12,522	52,364	16	786	12,541	53,153
California	5	7,934	267,583	147	7,718	8,479	348,152
Colorado	0	1,362	16,479	185	5,934	2,062	32,774
Connecticut	0	3,354	15,541	3,293	55,542	7,127	79,625
Delaware	1	4,538	20,479	1,305	19,244	6,519	48,781
District of Columbia	0	44	627	1	186	46	825
Florida	0	8,177	96,554	103	6,912	9,010	141,665
Georgia	27	49,058	174,050	31	2,251	49,093	176,400
Idaho	35	37,549	426,736	66	2,758	40,820	477,585
Illinois	49	28,691	202,182	5,575	166,416	178,846	1,546,397
Indiana	80	153,981	1,004,327	20,198	159,518	176,095	1,186,333
Iowa	54	143,023	2,070,436	3,051	78,526	216,919	3,609,104
Kansas	50	102,600	1,068,600	657	21,409	103,380	1,096,390
Kentucky	43	79,382	528,652	41	1,743	81,229	551,904
Louisiana	0	3,246	61,201	14	1,095	3,426	67,472
Maine	16	42,803	221,457	961	16,749	43,817	238,761
Maryland	1	16,627	81,695	9,219	116,318	33,552	229,551
Massachusetts	1	3,450	32,780	2,172	28,886	6,147	69,436
Michigan	82	183,866	1,495,454	75	3,653	185,070	1,506,940
Minnesota	47	102,248	1,601,234	9,143	180,770	112,616	1,798,982
Mississippi	6	10,890	146,053	28	1,686	10,918	147,740
Missouri	12	82,428	720,320	219	9,317	86,261	779,226
Montana	[1] 13	32,937	336,245	62	4,222	36,426	584,463
Nebraska	42	79,217	1,029,019	125	5,527	80,049	1,050,007
Nevada	3	2,277	48,148	16	1,005	2,586	66,301
New Hampshire	2	3,123	26,995	4,625	61,553	8,108	92,323
New Jersey	0	4,667	14,400	3,832	19,881	12,256	44,341
New Mexico	0	2,908	23,027	24	1,987	3,010	25,502
New York	12	27,800	235,867	80,188	788,758	117,626	1,146,880
North Carolina	100	256,617	670,554	307	10,871	256,924	681,425
North Dakota	36	57,114	908,539	5,363	109,926	68,872	1,166,404
Ohio	51	211,446	1,332,148	828	19,940	217,908	1,555,024
Oklahoma	1	2,877	44,129	262	10,711	3,155	56,284
Oregon	8	27,659	208,399	494	11,927	28,169	220,403
Pennsylvania	31	118,324	643,437	6,027	104,409	134,391	1,060,279
Rhode Island	0	249	2,953	134	2,346	713	7,500
South Carolina	16	70,461	207,875	113	5,098	70,635	214,535
South Dakota	5	9,784	180,662	1,292	30,976	11,218	215,397
Tennessee	13	73,386	359,461	133	6,898	73,626	371,119
Texas	1	35	1,236	426	15,135	600	29,698
Utah	1	11,992	89,206	99	2,908	12,457	93,944
Vermont	[2]	2,847	43,186	7,523	146,064	12,571	239,062
Virginia	36	55,275	213,644	976	30,911	56,530	255,946
Washington	[3] 15	45,898	404,334	89	3,419	50,071	517,252
West Virginia	27	63,335	667,689	640	14,070	65,139	302,689
Wisconsin	53	169,626	2,674,221	12,414	331,082	186,878	3,131,886
Wyoming	0	11,211	125,673	3	208	12,576	141,953
Alaska	0	89	935	0	0	102	954
Hawaii	0	0	0	0	0	724	17,628
Total	976	2,438,454	20,983,869	182,858	2,646,686	2,919,503	27,692,306

[1] Part of 1 county not included.
[2] 43 towns.
[3] Parts of 2 counties not included.

MEASURES OF PREVENTION

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regulating the movements of cattle, and with that object in view, action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the livestock owner. If each livestock owner takes an active part all through the campaign of tuberculosis eradication, and

if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped whenever possible. After diseased animals are found and removed from the premises, a *very thorough* cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant. The use of disinfectants without first doing the necessary and proper cleaning is ineffective for the reason that the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences, can then be sprayed properly with the disinfectant.

All this means much work, but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where livestock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

TABLE 4.—*Progress of cooperative tuberculin testing, 1917–1930*

Fiscal year	Herds tested	Cattle tested	Reactors found	Per cent reactors
1917		20, 101	645	3. 2
1918		134, 143	6, 544	4. 9
1919		329, 878	13, 528	4. 1
1920	40, 348	700, 670	28, 709	4. 1
1921	86, 687	1, 366, 358	53, 768	3. 9
1922	195, 220	2, 384, 236	82, 569	3. 5
1923	296, 138	3, 460, 849	113, 844	3. 3
1924	455, 034	5, 312, 364	171, 559	3. 2
1925	607, 345	7, 000, 028	214, 491	3. 1
1926	774, 728	8, 650, 780	323, 084	3. 7
1927	871, 561	9, 700, 176	285, 361	2. 9
1928	1, 048, 277	11, 281, 490	262, 113	2. 3
1929	1, 030, 679	11, 683, 720	206, 764	1. 8
1930	1, 102, 423	12, 845, 871	216, 932	1. 7

MARKING ANIMALS FOR IDENTIFICATION

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified. One method that is quite generally used is that of branding; a letter "T" about 2 inches high is branded on the left lower jaw. In addition to the branding, the reacting animals should be properly tagged so that each one may be positively identified, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is usually placed in the left ear of the animal and contains a serial number as well as the word "Reactor."

The marking of cattle that have passed the tuberculin test is a matter that is being handled in different ways throughout the United

States. In some cases a metal ear tag is used and in others certain marks of identification are tattooed in the ear. It is not often necessary to require special marks on purebred registered cattle, as the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking to show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine to show the origin of those found to be tuberculous on post-mortem examination consists in tattooing a number or mark of identification into the skin of the hog. The method is fully described in Miscellaneous Circular 57, "The Tattoo Method of Marking Hogs and Its Use."

Many shipments which contain tuberculous swine are traced back to the farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised, efforts can be directed in eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY

In addition to the various benefits derived from eradicating tuberculosis, provision for the appraisement of diseased cattle with idemnity for those slaughtered is a further incentive. Federal legislation and supplementary laws in numerous States now divide the burden of loss, so that the Government, the State, and the owner of the cattle all bear a share of it. Briefly, the Federal law provides that the Secretary of Agriculture may reimburse, in part, owners of animals destroyed on account of tuberculosis in cooperation with States, counties, and municipalities. The bases upon which Federal indemnities are paid are:

1. No payment shall exceed one-third of the difference between the appraised value of such animal and the salvage value.
2. No payment shall exceed the amount paid or to be paid by the State, county, or municipality.
3. In no case shall any payment be more than $35 for any grade animal or more than $70 for any purebred animal.
4. No payment shall be made unless the owner has complied with all lawful quarantine regulations.

Legislation regarding indemnities for tuberculous cattle varies somewhat in different States, and for detailed and current information on the subject the reader is referred to his State livestock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained by addressing the Bureau of Animal Industry, U. S. Department of Agriculture.

A careful study of Figures 5, 7, 8, and 9 in this bulletin will enable the reader to become familiar with the appearance of the parts of the body most commonly affected. He will also see, even more clearly than can be described, that a real danger exists in permitting diseased animals or those of doubtful health to mingle with others. The illustrations of the accredited herds, on the other hand, show the splendid types of cattle which their owners have subjected to the tuberculin test and which have passed it successfully.

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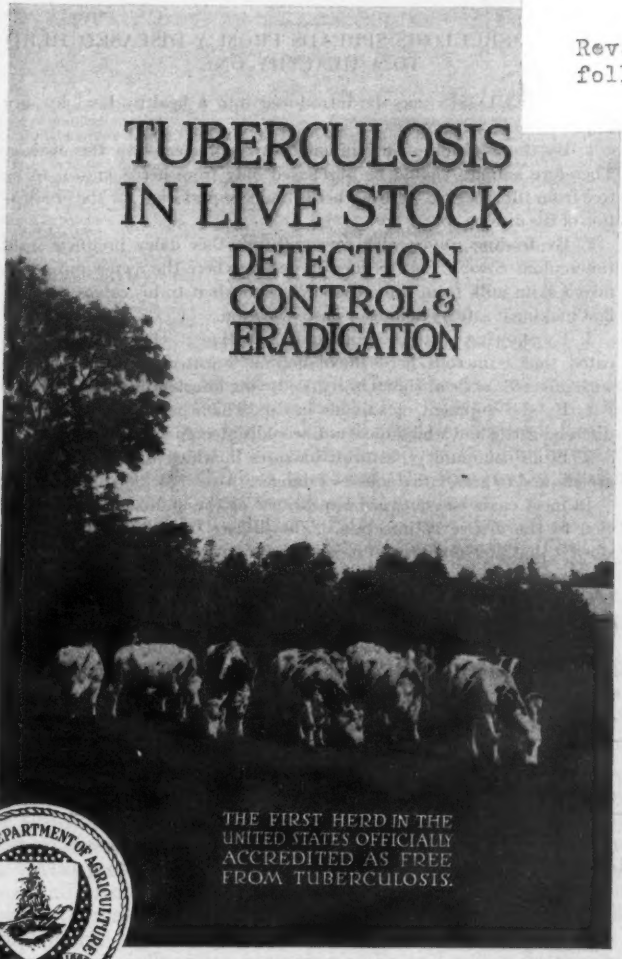
TUBERCULOSIS IN LIVE STOCK

DETECTION CONTROL & ERADICATION



THE FIRST HERD IN THE UNITED STATES OFFICIALLY ACCREDITED AS FREE FROM TUBERCULOSIS.

XUM

HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

1. By the addition of an animal that is affected with the disease. Therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

2. By feeding calves with raw milk or other dairy products from tuberculous cows. This frequently occurs where the owner purchases mixed skim milk from the creamery and feeds it to his calves without first making it safe by boiling or pasteurization.

3. By showing cattle at fairs and exhibitions. Reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

4. By the shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

5. From community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the United States Department of Agriculture, the livestock sanitary officials of the various States, and individual cattle owners.

Washington, D.C.

Issued November 1919
Revised November 1933

TUBERCULOSIS IN LIVESTOCK

DETECTION, CONTROL, AND ERADICATION[1]

By ALEXANDER E. WIGHT, *Chief, Tuberculosis Eradication Division, Bureau of Animal Industry*

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PRESENT KNOWLEDGE OF TUBERCULOSIS

PROBABLY no disease affecting either the human race or livestock is better known or has been the object of so much study as tuberculosis. Knowledge of the disease is derived from many sources, including the work of eminent scientists who have studied the numerous ways in which it is spread, the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1890 by the eminent scientist, Robert Koch. Thus the test has been known for more than 40 years. The facts regarding it and other information presented in this bulletin are based on long experience and scientific evidence. The methods recommended to be used in the eradication of tuberculosis have been tried and found to be effectual and practicable.

IMPORTANCE OF ERADICATION WORK

The elimination of bovine tuberculosis from a farm and surrounding territory gives a cattle owner numerous advantages, chief among which are increased prices received for surplus breeding cattle and the greater assurance that other livestock on the same farm will not contract tuberculosis. Another important consideration is that of human health. Many cases of tuberculosis among children are traceable to the use of milk from tuberculous cows. If milk is properly pasteurized the living organisms of tuberculosis are destroyed, but raw milk and milk improperly pasteurized may be sources of danger. Many cities and towns have ordinances requiring milk and other dairy products to come from herds that are free from tuberculosis.

[1] This is a revision of former editions by John A. Kiernan, formerly chief of the division, and Dr. Wight. Dr. Kiernan died in 1927.

XUM

TUBERCULOSIS A DECEPTIVE DISEASE

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among livestock owners, who would insist upon its immediate eradication; but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals (fig. 1), many people believe that it does comparatively little damage among livestock. Contrary to such opinions, however, the loss from tuberculosis is one of the heaviest taxes imposed upon our livestock industry, amounting, probably, to at least $40,000,000 a year in the United States prior to the time when systematic eradication work was begun.

FIGURE 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. On application of the tuberculin test, 37, or 82 percent of the animals, were found to be tuberculous. The germs of the disease may live for months in manure or litter.

PREVALENCE OF TUBERCULOSIS

The tuberculin test was used to some extent in the United States soon after its discovery, and there was a gradual increase in its use until 1917, when the cooperative campaign was undertaken by the Federal Government and several of the States. During the early part of the campaign there was some tuberculosis in every State and Territory although the degree varied considerably. As the campaign progressed the extent of infection was reduced to 0.5 percent or less of the cattle population in county after county. These counties were designated as modified accredited areas and are considered to be practically free of bovine tuberculosis.

The location of these modified accredited areas is shown in white on the map in figure 2. The vast extent of these areas is conclusive evidence that the early predictions of well-known officials were justified. The late John A. Kiernan, former chief of the Tuberculosis Eradication Division of the Bureau of Animal Industry and coauthor of this bulletin in its original form, firmly believed that with full cooperation of State and local officials bovine tuberculosis could be eradicated from the United States. Similar predictions of State officials have already been realized.

In order to keep officials and other interested persons informed as to the progress of the campaign, the Department issues a monthly summary in mimeographed form showing the number of tests, number of modified accredited counties, and other information for each State. In addition to this the Department issues maps showing the extent of the disease, following Nation-wide surveys which determine the approximate percentage of infection in each county, State, and Territory.

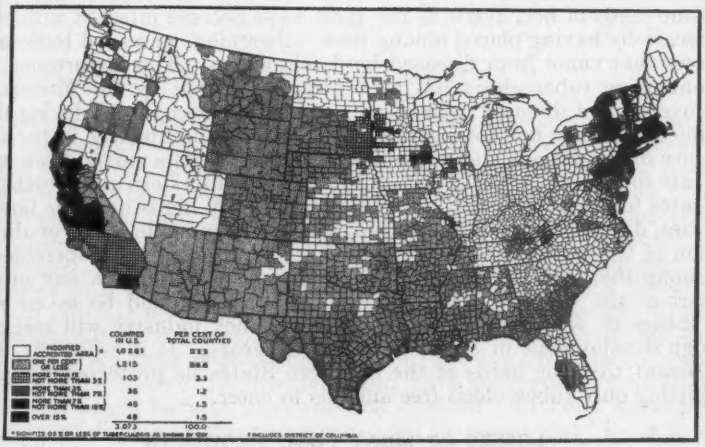

FIGURE 2.—Extent of bovine tuberculosis in the United States, July 1, 1933.

The results of the six biennial surveys, which are shown in the following tabulation, indicate how the infection has gradually decreased since the eradication work was well under way:

Year:	*Percent of cattle tuberculous*	Year:	*Percent of cattle tuberculous*
1922	4.0	1928	2.0
1924	3.3	1930	1.7
1926	2.8	1932	1.4

Tuberculosis is known to exist quite extensively among cattle and swine in all the European countries; in fact, no large part of the world is known to be absolutely free from it. There are, however, some restricted regions where its presence is not known or where it exists in but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States tuberculosis among livestock in those regions was unknown. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but livestock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the livestock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

In some localities in the West where dairying has developed extensively it is now known that carload lots of cows purchased in other States have contained 50 percent or more of tuberculous animals. Some herds of beef cattle in the West have become infected with the disease by having placed among them tuberculous purebred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is today. Consequently, in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick. Therefore there is probably less tuberculosis among the herds of the Southern States than in those in any other part of the Nation. This favorable condition should be taken advantage of, for in all probability the livestock industry will reach a high development in that area in future years. It is especially important that the herds of the Southern States be protected by permitting only tuberculosis-free animals to enter.

LOSSES OF MEAT FOOD PRODUCTS

Records kept by the Meat Inspection Division of the Bureau of Animal Industry indicate the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 percent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 percent of these classes of animals slaughtered each year in the United States do not appear in these records. The losses shown in table 1 are therefore considerably less than the total loss throughout the country.

TABLE 1.—*Number of cattle, except known reactors, and swine slaughtered and those retained, condemned, and sterilized on account of tuberculosis, at establishments where Federal meat inspection is maintained*

Fiscal year	Cattle			Swine		
	Slaughtered	Retained [1]	Condemned and sterilized	Slaughtered	Retained [1]	Condemned and sterilized
1917	9,276,049	195,488	49,214	40,210,847	3,978,168	168,350
1918	10,912,417	196,917	46,235	35,449,247	3,494,587	148,655
1919	11,212,543	176,250	42,729	44,398,389	4,103,376	165,538
1920	9,666,188	157,016	39,305	38,981,914	4,260,719	159,873
1921	8,137,982	132,068	33,312	37,702,866	4,693,305	161,064
1922	7,795,323	146,945	34,712	39,416,439	5,640,081	166,113
1923	8,934,975	156,738	41,113	48,600,069	7,139,925	202,490
1924	9,049,342	141,595	39,333	54,416,481	8,293,965	225,110
1925	9,595,969	145,012	40,374	48,459,608	7,039,724	192,610
1926	9,817,599	138,506	41,125	40,442,730	5,667,093	145,394
1927	9,810,797	112,924	31,755	42,650,443	5,778,009	132,888
1928	8,837,882	91,856	25,664	48,347,393	5,872,503	125,505
1929	8,120,992	81,276	21,265	47,163,573	5,408,910	104,654
1930	8,119,760	61,192	15,487	46,688,860	5,321,352	96,164
1931	8,061,749	50,725	12,430	44,020,633	5,174,343	88,354
1932	7,793,878	38,446	9,307	45,852,422	5,222,420	83,160
1933	7,554,258	31,971	7,993	45,698,053	4,820,152	76,449

[1] Held for more complete examination to determine final disposal.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is placed aside for further examination. If the disease is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed, and the remainder is passed. It will be noted that such is the case in most carcasses retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In animals in which the disease is not extensive enough to cause condemnation of the entire carcass the disease is usually in the early stages. Had the animals been allowed to live for possibly only a short time longer the disease would have progressed until all the carcass would have to be considered diseased. In some animals the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and so endanger healthy cattle and swine.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger, State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from those farms.

CAUSE OF TUBERCULOSIS

The cause of tuberculosis is a rod-shaped germ (*Mycobacterium tuberculosis*) discovered by Robert Koch in 1882. This organism can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or livestock

is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself, except as mentioned previously. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures, paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other enclosures which have contained tuberculous animals, before healthy ones are again placed in them.

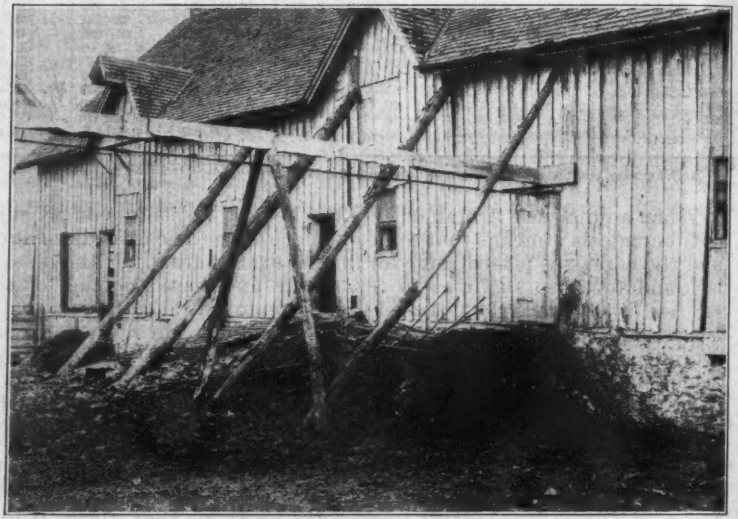

FIGURE 3.—An insanitary barn. Nearly all the cows kept in it were tuberculous. Premises of this character cannot be kept sanitary.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuberculosis among the stock whenever the germs are present (figs. 3 and 4). Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket that the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued

forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED

The tuberculous cow is the greatest source of danger to healthy cattle. Inasmuch as it cannot be determined just when that animal becomes a "spreader" of the germs unless daily microscopic tests are made of the milk and of the discharges from the body, it is unsafe to keep her with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin-tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming in contact with affected animals than in any other way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

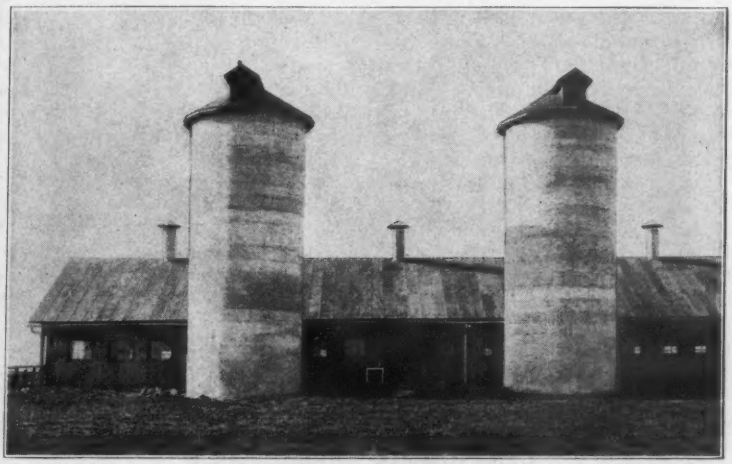

FIGURE 4.—A modern sanitary barn. Note ventilators and liberal window space.

The common water trough, especially in barns, is also the cause, to a very large extent, of spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which the infected milk or the washings from infected milk cans have been dumped may also be a source of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected by drinking raw milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable

attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE BECOME INFECTED

The tuberculous cow is not only a menace to other cattle but is also a source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the distribution of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record also in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are allowed to mingle with them on the same farm, some of the swine are tuberculous. Eradication of tuberculosis from cattle has greatly reduced its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States, is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuberculosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another. Investigations indicate that a large percentage of hogs found to be slightly affected with tuberculosis have contracted the avian type of infection from poultry.[2]

SYMPTOMS OF TUBERCULOSIS

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms (fig. 1). Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening. Cattle affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an ani-

[2] Farmers' Bulletin 1652 describes and gives information on fowl tuberculosis.

mal are affected it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased the animal may develop bloat (fig. 5). Diarrhea is evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

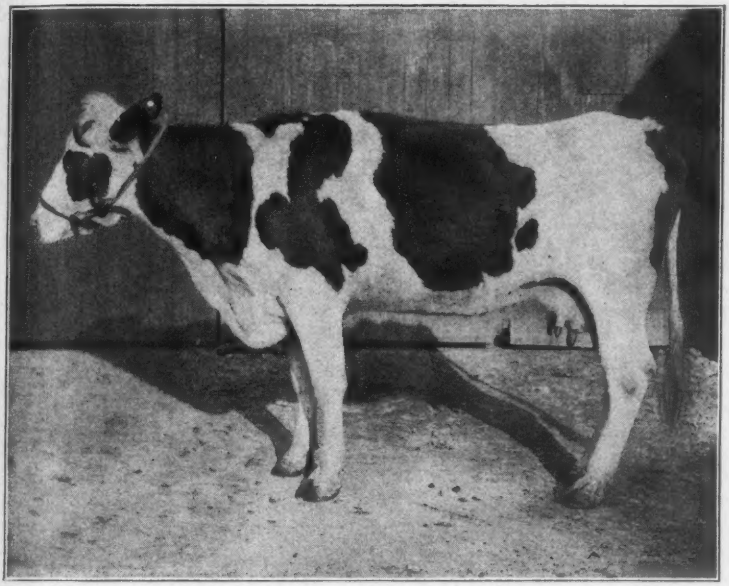

FIGURE 5.—A reacting cow that was constantly bloating. The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating.

METHODS OF DIAGNOSIS

Microscopic examinations of the sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of experience the tuberculin test is now considered to be the most practicable and satisfactory way of diagnosing the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

XUM

THE TUBERCULIN TEST

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and used by skillful veterinarians, it is a reliable agent for detecting tuberculosis in animals. Tuberculin contains no tubercle bacilli but is a product of the growth of the germs, properly mixed with a substance on which it has grown and then properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used. Moreover, there is no basis for the claim that the use of the tuberculin test will in any way affect a cow's ability to produce. There are thousands of high producers that are given the tuberculin test annually (fig. 6).

FIGURE 6.—A purebred Guernsey cow that produced 5 sons and 10 daughters, 6 of which made advanced-registry records. She lived until nearly 22 years old, receiving the tuberculin test annually, but showed no reaction or ill effects from the tests. One of her granddaughters made two advanced-registry records and sold at auction for $3,000.

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action. Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to a second application made within a short time; therefore it may be misused by unscrupulous persons.

THE INTRADERMIC TEST (INTO THE SKIN)

The intradermic, also known as the intracutaneous, test for detecting tuberculosis is used extensively. When made by those who have become skilled in its application it is very accurate. In this test the

tuberculin is injected between the layers of the skin, and it is usually applied in the region at the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine, and when so used the tuberculin is applied in the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is usually observed from 72 to 120 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced veterinarian.

THE OPHTHALMIC TEST (OR EYE TEST)

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the other two methods here described. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit.

In all cases the tests, used either alone or in combination, should be applied by capable veterinarians familiar with tuberculin testing.

THE SUBCUTANEOUS TEST (UNDER THE SKIN)

The subcutaneous test is made by injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to take the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are taken at least three times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the veterinarian who applies the test, and a careful observance of any clinical changes is always important in determining the result. It cannot be set forth too strongly that all forms of the tuberculin test should be attempted only by those who are properly qualified to do the work.

POST-MORTEM APPEARANCES

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or

if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs (figs. 7 and 8). The lesions are of various sizes and may contain pus, either soft or hard. Frequently the pus is gritty, especially in swine. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities (fig. 9). Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands are usually affected to some extent, and, when cut into, show diseased areas characteristic of tuberculosis.

FIGURE 7.—Part of a tuberculous udder showing well-developed lesions.

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible even for a person skilled in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals that reacted to the test were not affected with tuberculosis to some extent, even though some of the reactions were very slight.[3]

ERADICATION PROJECTS

Four main projects comprise the general campaign of eradication:

(1) Eradication of tuberculosis from purebred or other individual herds of cattle.
(2) Eradication of tuberculosis from cattle in circumscribed areas.
(3) Eradication of tuberculosis from swine.
(4) Eradication of tuberculosis from poultry.

ACCREDITED-HERD OR HONOR-ROLL PLAN

The accredited-herd or honor-roll plan applies to individual herds. Herds found to be free from tuberculosis on two successive annual tests (fig. 10) are placed on the honor roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of 1 year. This plan has become well known to breeders throughout the United States.

[3] For further information on this subject, see Miscellaneous Publication No. 59, Reliability of the Tuberculin Test.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for purebreds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly tuberculin tested. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

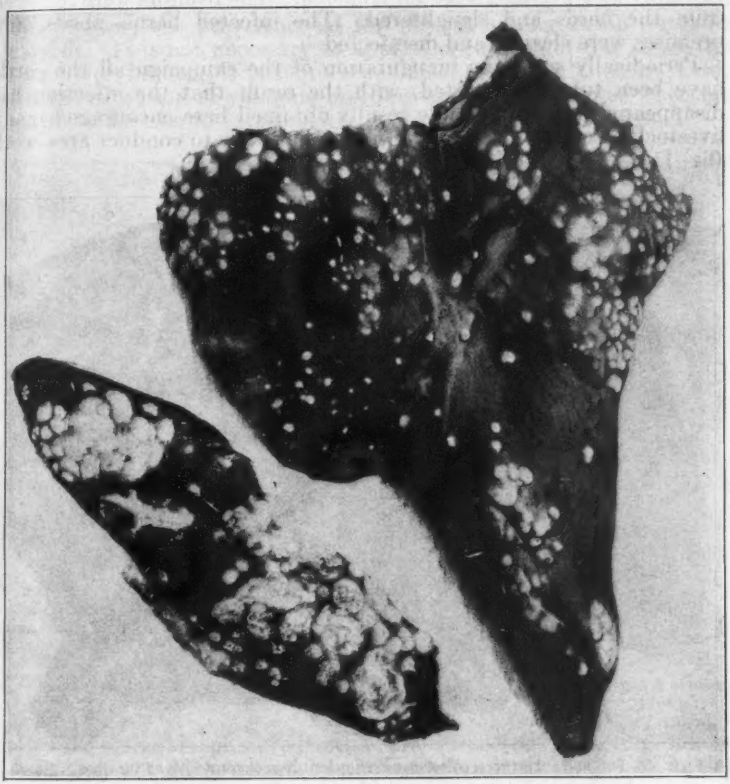

FIGURE 8.—Liver and spleen showing extensive lesions of tuberculosis.

ERADICATION FROM CATTLE IN CIRCUMSCRIBED AREAS

As a general rule, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county may pay (1) part of the expense of exterminating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it may be advisable to clean up the herds within a township or possibly one third or one half of the area. The progress depends

upon the degree of infection found and the cooperation furnished by the owners.

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of about 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin tested; of the total number, 321 cattle, or 18.9 percent, were tuberculous. The reactors were removed from the herds and slaughtered. The infected barns, sheds, and premises were cleaned and disinfected.

Periodically since the inauguration of the campaign all the cattle have been tuberculin tested, with the result that the infection has disappeared. The favorable results obtained here encouraged many livestock owners and State and Federal officials to conduct area work (fig. 11).

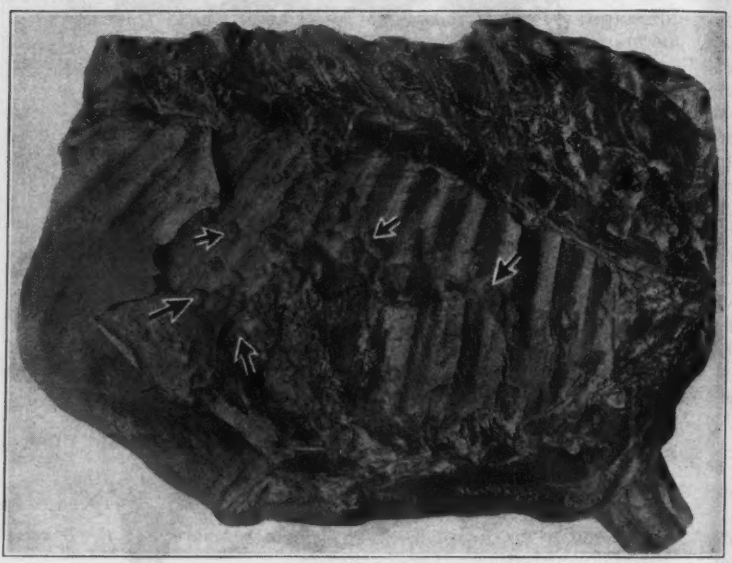

FIGURE 9.—Portion of a beef carcass showing tuberculous nodules on the ribs.

The plan of carrying on eradication under the area plan is practicable and is being conducted in almost all States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The intradermic method should be used, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermic test, the entire herd should be tested again within from 60 to 90 days.

When not more than one half of 1 percent of the cattle in a given area, usually a county, are found to be affected with tuberculosis,

such area is declared to be a "modified accredited area." Cattle from such areas may be moved interstate without further tuberculin test. The first counties were accredited in July 1923 and 1,626 counties had been accredited up to July 1, 1933.

ERADICATION FROM SWINE

With the gradual elimination of tuberculosis from cattle and also from poultry, the prevalence of the disease among swine tends to diminish. It is not necessary to apply the tuberculin test to all the swine herds because it is more economical to send the entire herd, with the exception of valuable breeding animals, to market when fat than to undertake to exterminate the disease in any other way.

FIGURE 10.—Part of an accredited Holstein-Friesian herd in Virginia. This herd has been free of tuberculosis since 1923.

In case valuable purebred swine are suspected of having tuberculosis they should be tested by the intradermic method. As in the case of cattle, diseased swine should be removed from the farm, and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

ERADICATION FROM POULTRY

Tuberculosis in poultry is caused by a different type of the tubercle bacillus, known as the "avian" type. The disease is very prevalent in the Central and North Central States. In some sections of this area from 50 to 75 percent of the poultry flocks are affected with this disease. Swine are very susceptible to avian tuberculosis, and this fact increases the importance of controlling and eradicating this type of tuberculosis. The disease can be placed under control, and eventually

eradicated, by following approved methods of sanitation and poultry husbandry.[4]

PROGRESS OF ERADICATION

The campaign for the systematic eradication of tuberculosis from livestock has met with increasing favor. Applications for testing are far in excess of the capacity of the available forces and appropriations, and there is always a waiting list of herd owners desiring to have their cattle tested. Table 2 shows the progress made since the early stage of the campaign. Records of the Bureau of Animal

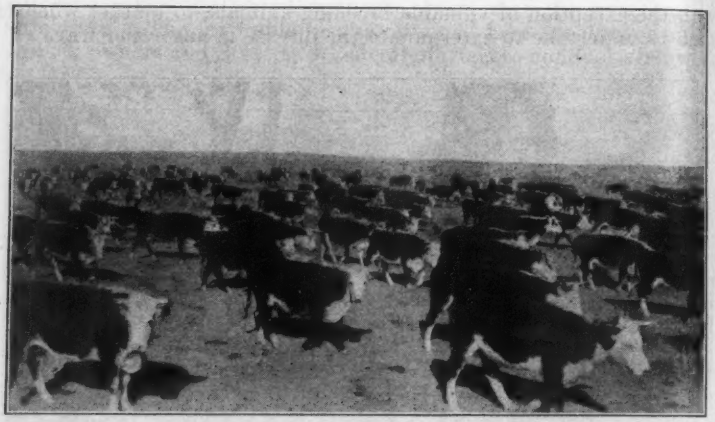

FIGURE 11.—Part of a large herd of Hereford cattle in the range area of Texas. When this herd was tested there were no reactors. The entire county in which this herd ranges is now a modified accredited area.

Industry show that during recent years the testing has progressed at the rate of more than a million cattle a month.

TABLE 2.—*Progress of tuberculosis eradication work in cooperation with States, 1917–33*

Fiscal year	Herds tested	Cattle tested	Reactors found		Fiscal year	Herds tested	Cattle tested	Reactors found	
			Number	Percent				Number	Percent
1917		20,101	645	3.2	1926	774,728	8,650,780	323,084	3.7
1918		134,143	6,544	4.9	1927	871,561	9,700,176	285,361	2.9
1919		329,878	13,528	4.1	1928	1,048,277	11,281,490	262,113	2.3
1920	40,348	700,670	28,709	4.1	1929	1,030,679	11,683,720	206,764	1.8
1921	86,687	1,366,358	53,768	3.9	1930	1,102,423	12,845,871	216,932	1.7
1922	195,220	2,384,236	82,569	3.5	1931	1,162,414	13,782,273	203,778	1.5
1923	296,138	3,460,849	113,844	3.3	1932	1,139,119	13,443,557	254,785	1.9
1924	455,034	5,312,364	171,559	3.2	1933	1,110,306	13,073,894	255,096	2.0
1925	607,345	7,000,028	214,491	3.1					

[4] Further information regarding avian tuberculosis may be obtained in Leaflet 102, Eradicating Tuberculosis from Poultry and Swine.

MEASURES OF PREVENTION

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regulating the movements of cattle, and with that object in view, action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the livestock owner. If each livestock owner takes an active part all through the campaign of tuberculosis eradication, and if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped whenever possible. After diseased animals are found and removed from the premises, a very thorough cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant.[5] Using disinfectants without first doing the necessary and proper cleaning is ineffective, as the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences, can then be sprayed properly with the disinfectant.

All this means much work, but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where livestock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

MARKING ANIMALS FOR IDENTIFICATION

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified. Reactors are branded on the left lower jaw with a letter T about 2 inches high. In addition to the branding, the reacting animals should be properly tagged so that each one may be positively identified, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is placed in the left ear of the animal and contains a serial number as well as the word "Reactor."

Cattle that have passed the tuberculin test are marked by a numbered metal ear tag which is placed in the right ear. It is not often necessary to require special marks on purebred registered cattle, as

[5] Farmers' Bulletin 954, The Disinfection of Stables, gives further information concerning the use of disinfectants for premises.

the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking to show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine to show the origin of those found to be tuberculous on post-mortem examination consists in tattooing a number or mark of identification into the skin of the hog. The method is fully described in Miscellaneous Circular 57, The Tattoo Method of Marking Hogs and Its Use.

Many shipments which contain tuberculous swine are traced back to the originating farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised, efforts can be directed toward eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY

In addition to the various benefits derived from eradicating tuberculosis, provision for the appraisement of diseased cattle with indemnity for those slaughtered is a further incentive. Federal legislation and supplementary laws in 46 States and Alaska and Hawaii now divide the burden of loss, so that the Government, the State or Territory, and the owner of the cattle all bear a share of it. Briefly, the Federal law provides that the Secretary of Agriculture may reimburse, in part, owners of animals destroyed on account of tuberculosis in cooperation with States, counties, and municipalities. The following are the bases upon which Federal indemnities are paid:

No payment shall exceed one third of the difference between the appraised value of such animal and the salvage value.

No payment shall exceed the amount paid or to be paid by the State, county, or municipality.

In no case shall any payment be more than $20 for any grade animal or more than $50 for any purebred animal.

No payment shall be made unless the owner has complied with all lawful quarantine regulations.

Legislation regarding indemnities for tuberculous cattle varies somewhat in different States, and for detailed and current information on the subject the reader is referred to his State livestock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained by addressing the Bureau of Animal Industry, United States Department of Agriculture, Washington, D.C.

A careful study of figures 7, 8, and 9 in this bulletin will enable the reader to become familiar with the appearance of the parts of the body most commonly affected. He will also see, even more clearly than can be described, that a real danger exists in permitting diseased animals or those of doubtful health to mingle with others. The illustrations of the accredited herds, on the other hand, show the splendid types of cattle which, when subjected by their owners to the tuberculin test, have passed it successfully.

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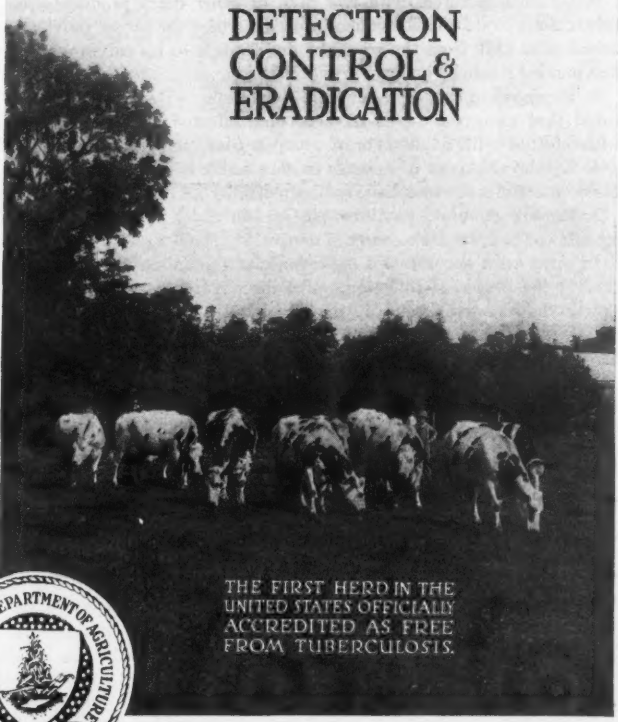
FARMERS' BULLETIN No. 1069

Jan. 1936

Rev.ed. follows

TUBERCULOSIS IN LIVE STOCK

DETECTION CONTROL & ERADICATION



THE FIRST HERD IN THE UNITED STATES OFFICIALLY ACCREDITED AS FREE FROM TUBERCULOSIS.

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HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

1. By the addition of an animal that is affected with the disease. Therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

2. By feeding calves with raw milk or other dairy products from tuberculous cows. This frequently occurs where the owner purchases mixed skim milk from the creamery and feeds it to his calves without first making it safe by boiling or pasteurization.

3. By showing cattle at fairs and exhibitions. Reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

4. By the shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

5. From community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the United States Department of Agriculture, the livestock sanitary officials of the various States, and individual cattle owners.

Washington, D.C.

Issued November 1919
Revised November 1933
Slightly Revised January 1936

TUBERCULOSIS IN LIVESTOCK

DETECTION, CONTROL, AND ERADICATION[1]

By ALEXANDER E. WIGHT, *Chief, Tuberculosis Eradication Division, Bureau of Animal Industry*

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PRESENT KNOWLEDGE OF TUBERCULOSIS

PROBABLY no disease affecting either the human race or livestock is better known or has been the object of so much study as tuberculosis. Knowledge of the disease is derived from many sources, including the work of eminent scientists who have studied the numerous ways in which it is spread, the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1890 by the eminent scientist, Robert Koch. Thus the test has been known for more than 40 years. The facts regarding it and other information presented in this bulletin are based on long experience and scientific evidence. The methods recommended to be used in the eradication of tuberculosis have been tried and found to be effectual and practicable.

IMPORTANCE OF ERADICATION WORK

The elimination of bovine tuberculosis from a farm and surrounding territory gives a cattle owner numerous advantages, chief among which are increased prices received for surplus breeding cattle and the greater assurance that other livestock on the same farm will not contract tuberculosis. Another important consideration is that of human health. Many cases of tuberculosis among children are traceable to the use of milk from tuberculous cows. If milk is properly pasteurized the living organisms of tuberculosis are destroyed, but raw milk and milk improperly pasteurized may be sources of danger. Many cities and towns have ordinances requiring milk and other dairy products to come from herds that are free from tuberculosis.

[1] This is a revision of former editions by John A. Kiernan, formerly chief of the division, and Dr. Wight. Dr. Kiernan died in 1927.

TUBERCULOSIS A DECEPTIVE DISEASE

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among livestock owners, who would insist upon its immediate eradication; but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals (fig. 1), many people believe that it does comparatively little damage among livestock. Contrary to such opinions, however, the loss from tuberculosis is one of the heaviest taxes imposed upon our livestock industry, amounting, probably, to at least $40,000,000 a year in the United States prior to the time when systematic eradication work was begun.

FIGURE 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. On application of the tuberculin test, 37, or 82 percent of the animals, were found to be tuberculous. The germs of the disease may live for months in manure or litter.

PREVALENCE OF TUBERCULOSIS

The tuberculin test was used to some extent in the United States soon after its discovery, and there was a gradual increase in its use until 1917, when the cooperative campaign was undertaken by the Federal Government and several of the States. During the early part of the campaign there was some tuberculosis in every State and Territory although the degree varied considerably. As the campaign progressed the extent of infection was reduced to 0.5 percent or less of the cattle population in county after county. These counties were designated as modified accredited areas and are considered to be practically free of bovine tuberculosis.

The location of these modified accredited areas is shown in white on the map in figure 2. The vast extent of these areas is conclusive evidence that the early predictions of well-known officials were justified. The late John A. Kiernan, former chief of the Tuberculosis Eradication Division of the Bureau of Animal Industry and coauthor of this bulletin in its original form, firmly believed that with full cooperation of State and local officials bovine tuberculosis could be eradicated from the United States. Similar predictions of State officials have already been realized.

In order to keep officials and other interested persons informed as to the progress of the campaign, the Department issues a monthly summary in mimeographed form showing the number of tests, number of modified accredited counties, and other information for each State. In addition to this the Department issues maps showing the

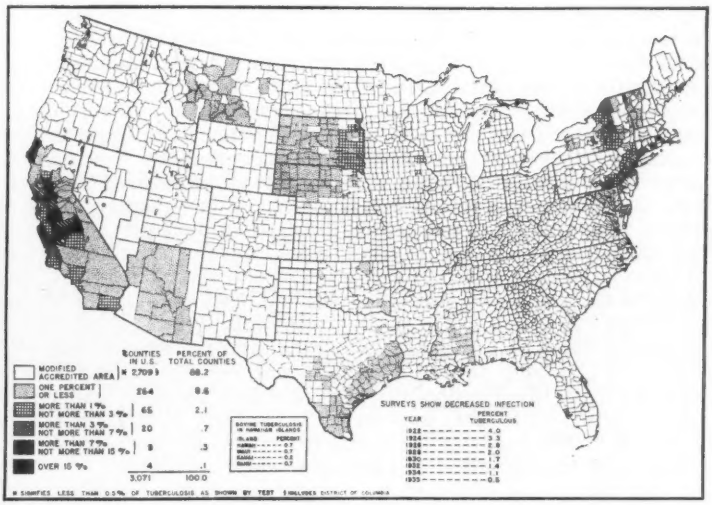

FIGURE 2.—Extent of bovine tuberculosis in the United States November 1, 1935.

extent of the disease, following Nation-wide surveys which determine the approximate percentage of infection in each county, State, and Territory.

The results of eight biennial surveys, shown below the map at the right, indicate that infection has gradually decreased since eradication work got well under way.

Tuberculosis is known to exist quite extensively among cattle and swine in all the European countries; in fact, no large part of the world is known to be absolutely free from it. There are, however, some restricted regions where its presence is not known or where it exists in but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States tuberculosis among livestock in those regions was unknown. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but livestock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the livestock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

In some localities in the West where dairying has developed extensively it is now known that carload lots of cows purchased in other States have contained 50 percent or more of tuberculous animals. Some herds of beef cattle in the West have become infected with the disease by having placed among them tuberculous purebred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is today. Consequently, in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick. Therefore there is probably less tuberculosis among the herds of the Southern States than in those in any other part of the Nation. This favorable condition should be taken advantage of, for in all probability the livestock industry will reach a high development in that area in future years. It is especially important that the herds of the Southern States be protected by permitting only tuberculosis-free animals to enter.

LOSSES OF MEAT FOOD PRODUCTS

Records kept by the Meat Inspection Division of the Bureau of Animal Industry indicate the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 percent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 percent of these classes of animals slaughtered each year in the United States do not appear in these records. The losses shown in table 1 are therefore considerably less than the total loss throughout the country.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is put aside for further examination. If the disease

TABLE 1.—*Number of cattle, except known reactors, and swine slaughtered and those retained, condemned, and sterilized on account of tuberculosis, at establishments where Federal meat inspection is maintained, 1917–35*

Fiscal year	Cattle			Swine		
	Slaughtered	Retained [1]	Condemned and sterilized	Slaughtered	Retained [1]	Condemned and sterilized
1917	9,276,049	195,488	49,214	40,210,847	3,978,168	168,350
1918	10,912,417	196,917	46,235	35,449,247	3,494,587	148,655
1919	11,212,543	176,250	42,729	44,398,389	4,103,376	165,538
1920	9,666,188	157,016	39,305	38,981,914	4,260,719	159,873
1921	8,137,982	132,068	33,312	37,702,866	4,693,305	161,064
1922	7,795,323	146,945	34,712	39,416,439	5,640,081	166,113
1923	8,934,975	156,738	41,113	48,600,069	7,139,925	202,490
1924	9,049,342	141,595	39,333	54,416,481	8,293,965	225,110
1925	9,595,969	145,012	40,374	48,459,608	7,039,724	192,610
1926	9,817,599	138,506	41,125	40,442,730	5,667,093	145,394
1927	9,810,797	112,924	31,755	42,650,443	5,778,009	132,888
1928	8,837,882	91,856	25,664	48,347,393	5,872,503	125,505
1929	8,120,992	81,276	21,265	47,163,573	5,408,910	104,654
1930	8,119,760	61,192	15,487	46,688,860	5,321,352	96,164
1931	8,061,749	50,725	12,430	44,020,633	5,174,343	88,354
1932	7,793,878	38,446	9,307	45,852,422	5,222,420	83,160
1933	7,554,258	31,971	7,993	45,698,053	4,820,152	76,449
1934	9,476,141	34,509	9,329	45,773,196	5,102,636	77,724
1935	12,563,474	30,569	8,273	34,413,317	3,714,828	52,687

[1] Held for more complete examination to determine final disposal.

is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed, and the remainder is passed. It will be noted that such is the case in most carcasses retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In animals in which the disease is not extensive enough to cause condemnation of the entire carcass the disease is usually in the early stages. Had the animals been allowed to live for possibly only a short time longer the disease would have progressed until all the carcass would have to be considered diseased. In some animals the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and so endanger healthy cattle and swine.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger, State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from those farms.

CAUSE OF TUBERCULOSIS

The cause of tuberculosis is a rod-shaped germ (*Mycobacterium tuberculosis*) discovered by Robert Koch in 1882. This organism can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or livestock

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is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself, except as mentioned previously. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures, paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other enclosures which have contained tuberculous animals, before healthy ones are again placed in them.

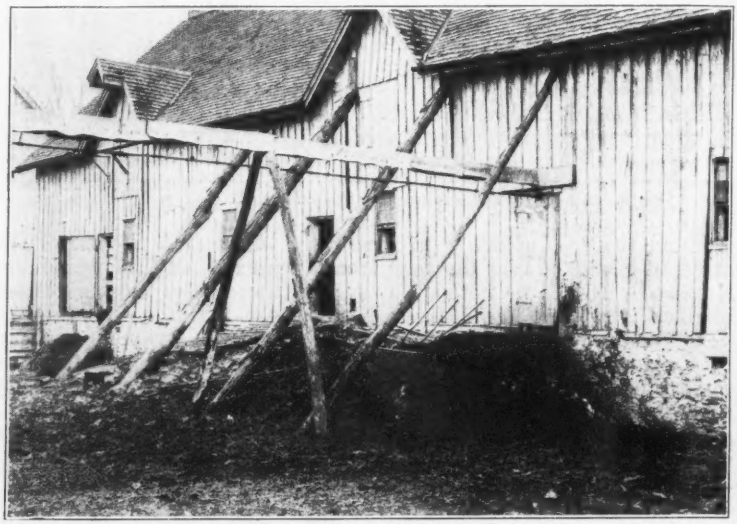

FIGURE 3.—An insanitary barn. Nearly all the cows kept in it were tuberculous. Premises of this character cannot be kept sanitary.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuberculosis among the stock whenever the germs are present (figs. 3 and 4). Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket that the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued

forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED

The tuberculous cow is the greatest source of danger to healthy cattle. Inasmuch as it cannot be determined just when that animal becomes a "spreader" of the germs unless daily microscopic tests are made of the milk and of the discharges from the body, it is unsafe to keep her with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin-tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming in contact with affected animals than in any other way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

FIGURE 4.—A modern sanitary barn. Note ventilators and liberal window space.

The common water trough, especially in barns, is also the cause, to a very large extent, of spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which the infected milk or the washings from infected milk cans have been dumped may also be a source of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected by drinking raw milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable

attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE BECOME INFECTED

The tuberculous cow is not only a menace to other cattle but is also a source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the distribution of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record also in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are allowed to mingle with them on the same farm, some of the swine are tuberculous. Eradication of tuberculosis from cattle has greatly reduced its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States, is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuberculosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another. Investigations indicate that a large percentage of hogs found to be slightly affected with tuberculosis have contracted the avian type of infection from poultry.[2]

SYMPTOMS OF TUBERCULOSIS

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms (fig. 1). Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening. Cattle affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an ani-

[2] Farmers' Bulletin 1652 describes and gives information on fowl tuberculosis.

mal are affected it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased the animal may develop bloat (fig. 5). Diarrhea is evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

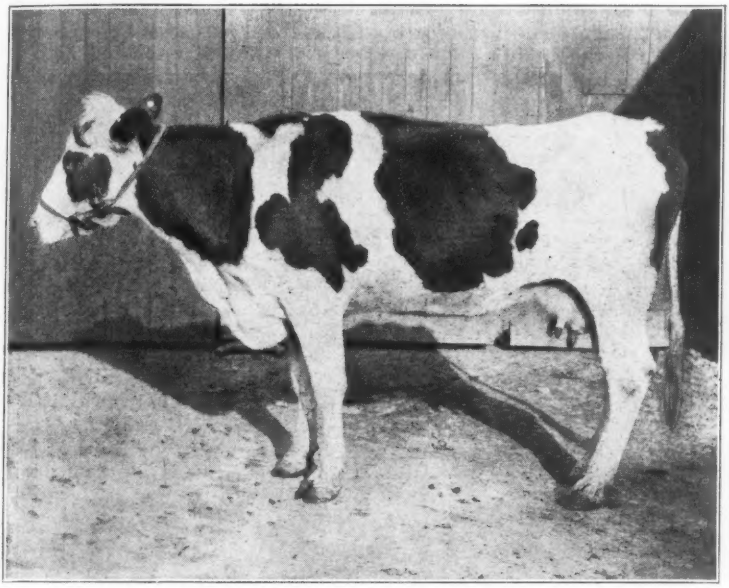

FIGURE 5.—A reacting cow that was constantly bloating. The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating.

METHODS OF DIAGNOSIS

Microscopic examinations of the sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of experience the tuberculin test is now considered to be the most practicable and satisfactory way of diagnosing the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

XUM

THE TUBERCULIN TEST

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and used by skillful veterinarians, it is a reliable agent for detecting tuberculosis in animals. Tuberculin contains no tubercle bacilli but is a product of the growth of the germs, properly mixed with a substance on which it has grown and then properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used. Moreover, there is no basis for the claim that the use of the tuberculin test will in any way affect a cow's ability to produce. There are thousands of high producers that are given the tuberculin test annually (fig. 6).

FIGURE 6.—A purebred Guernsey cow that produced 5 sons and 10 daughters, 6 of which made advanced-registry records. She lived until nearly 22 years old, receiving the tuberculin test annually, but showed no reaction or ill effects from the tests. One of her granddaughters made two advanced-registry records and sold at auction for $3,000.

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action. Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to a second application made within a short time; therefore it may be misused by unscrupulous persons.

THE INTRADERMIC TEST (INTO THE SKIN)

The intradermic, also known as the intracutaneous, test for detecting tuberculosis is used extensively. When made by those who have become skilled in its application it is very accurate. In this test the

tuberculin is injected between the layers of the skin, and it is usually applied in the region at the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine, and when so used the tuberculin is applied in the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is usually observed from 72 to 120 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced veterinarian.

THE OPHTHALMIC TEST (OR EYE TEST)

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the other two methods here described. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit.

In all cases the tests, used either alone or in combination, should be applied by capable veterinarians familiar with tuberculin testing.

THE SUBCUTANEOUS TEST (UNDER THE SKIN)

The subcutaneous test is made by injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to take the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are taken at least three times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the veterinarian who applies the test, and a careful observance of any clinical changes is always important in determining the result. It cannot be set forth too strongly that all forms of the tuberculin test should be attempted only by those who are properly qualified to do the work.

POST-MORTEM APPEARANCES

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or

if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs (figs. 7 and 8). The lesions are of various sizes and may contain pus, either soft or hard. Frequently the pus is gritty, especially in swine. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities (fig. 9). Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands are usually affected to some extent, and, when cut into, show diseased areas characteristic of tuberculosis.

FIGURE 7.—Part of a tuberculous udder showing well-developed lesions.

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible even for a person skilled in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals that reacted to the test were not affected with tuberculosis to some extent, even though some of the reactions were very slight.[3]

ERADICATION PROJECTS

Four main projects comprise the general campaign of eradication:

(1) Eradication of tuberculosis from purebred or other individual herds of cattle.
(2) Eradication of tuberculosis from cattle in circumscribed areas.
(3) Eradication of tuberculosis from swine.
(4) Eradication of tuberculosis from poultry.

ACCREDITED-HERD OR HONOR-ROLL PLAN

The accredited-herd or honor-roll plan applies to individual herds. Herds found to be free from tuberculosis on two successive annual tests (fig. 10) are placed on the honor roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of 1 year. This plan has become well known to breeders throughout the United States.

[3] For further information on this subject, see Miscellaneous Publication No. 59, Reliability of the Tuberculin Test.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for purebreds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly tuberculin tested. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

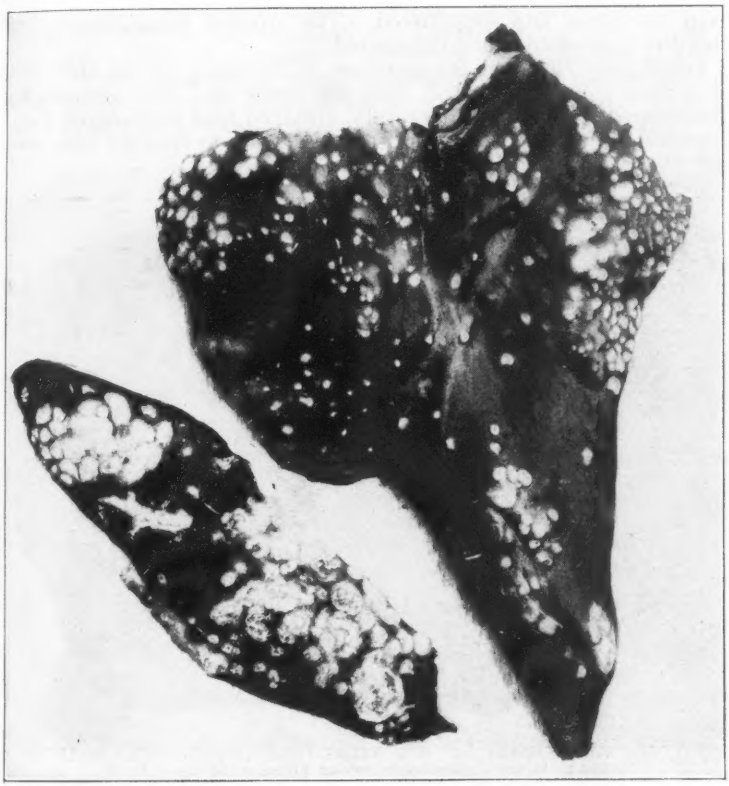

FIGURE 8.—Liver and spleen showing extensive lesions of tuberculosis.

ERADICATION FROM CATTLE IN CIRCUMSCRIBED AREAS

As a general rule, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county may pay (1) part of the expense of exterminating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it may be advisable to clean up the herds within a township or possibly one third or one half of the area. The progress depends

upon the degree of infection found and the cooperation furnished by the owners.

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of about 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin tested; of the total number, 321 cattle, or 18.9 percent, were tuberculous. The reactors were removed from the herds and slaughtered. The infected barns, sheds, and premises were cleaned and disinfected.

Periodically since the inauguration of the campaign all the cattle have been tuberculin tested, with the result that the infection has disappeared. The favorable results obtained here encouraged many livestock owners and State and Federal officials to conduct area work (fig. 11).

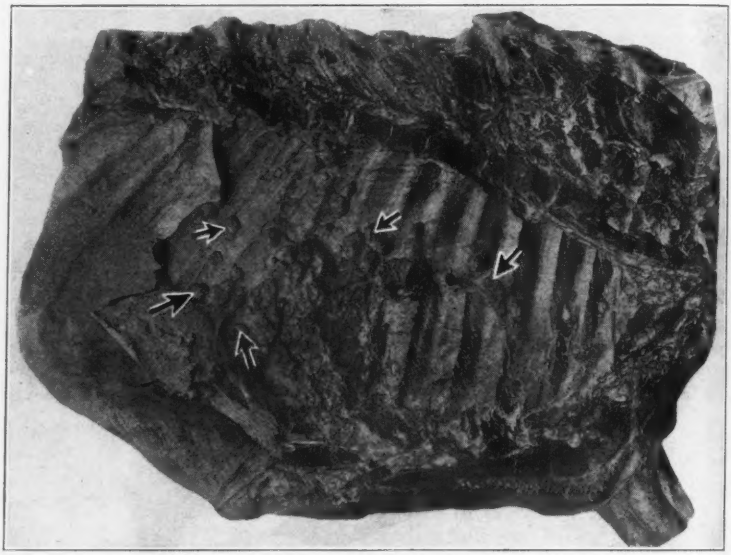

FIGURE 9.—Portion of a beef carcass showing tuberculous nodules on the ribs.

The plan of carrying on eradication under the area plan is practicable and is being conducted in almost all States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The intradermic method should be used, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermic test, the entire herd should be tested again within from 60 to 90 days.

When not more than one half of 1 percent of the cattle in a given area, usually a county, are found to be affected with tuberculosis,

such area is declared to be a "modified accredited area." Cattle from such areas may be moved interstate without further tuberculin test. The first counties were accredited in July 1923 and 2,709 counties had been accredited up to November 1, 1935.

ERADICATION FROM SWINE

With the gradual elimination of tuberculosis from cattle and also from poultry, the prevalence of the disease among swine tends to diminish. It is not necessary to apply the tuberculin test to all the swine herds because it is more economical to send the entire herd, with the exception of valuable breeding animals, to market when fat than to undertake to exterminate the disease in any other way.

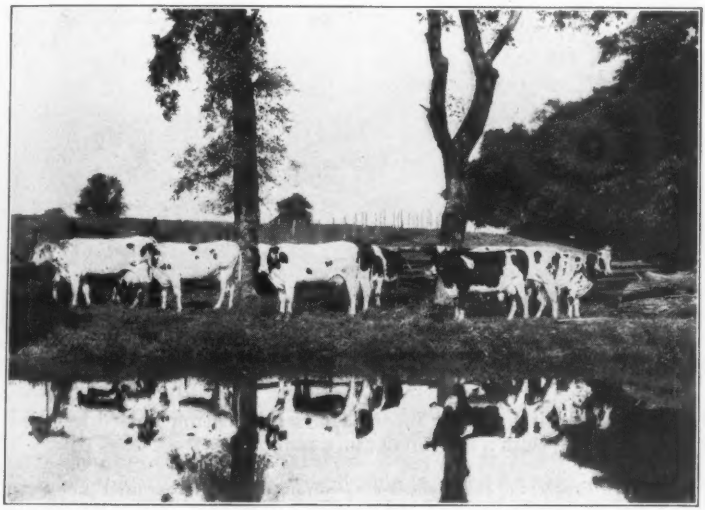

FIGURE 10.—Part of an accredited Holstein-Friesian herd in Virginia. This herd has been free of tuberculosis since 1923.

In case valuable purebred swine are suspected of having tuberculosis they should be tested by the intradermic method. As in the case of cattle, diseased swine should be removed from the farm, and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

ERADICATION FROM POULTRY

Tuberculosis in poultry is caused by a different type of the tubercle bacillus, known as the "avian" type. The disease is very prevalent in the Central and North Central States. In some sections of this area from 50 to 75 percent of the poultry flocks are affected with this disease. Swine are very susceptible to avian tuberculosis, and this fact increases the importance of controlling and eradicating this type of tuberculosis. The disease can be placed under control, and eventually

eradicated, by following approved methods of sanitation and poultry husbandry.[4]

PROGRESS OF ERADICATION

The campaign for the systematic eradication of tuberculosis from livestock has met with increasing favor. Applications for testing are far in excess of the capacity of the available forces and appropriations, and there is always a waiting list of herd owners desiring to have their cattle tested. Table 2 shows the progress made since the early stage of the campaign. Records of the Bureau of Animal

FIGURE 11.—Part of a large herd of Hereford cattle in the range area of Texas. When this herd was tested there were no reactors. The entire county in which this herd ranges is now a modified accredited area.

Industry show that during recent years the testing has progressed at the rate of more than a million cattle a month.

TABLE 2.—*Progress of tuberculosis-eradication work in cooperation with States, 1917–35*

Fiscal year	Herds tested	Cattle tested	Reactors found		Fiscal year	Herds tested	Cattle tested	Reactors found	
			Number	Percent				Number	Percent
1917		20,101	645	3.2	1927	871,561	9,700,176	285,361	2.9
1918		134,143	6,544	4.9	1928	1,048,277	11,281,490	262,113	2.3
1919		329,878	13,528	4.1	1929	1,030,679	11,683,720	206,764	1.8
1920	40,348	700,670	28,709	4.1	1930	1,102,423	12,845,871	216,982	1.7
1921	86,687	1,366,358	53,768	3.9	1931	1,162,414	13,782,273	203,778	1.5
1922	195,220	2,384,236	82,569	3.5	1932	1,139,119	13,443,567	254,785	1.9
1923	296,138	3,460,849	113,844	3.3	1933	1,110,306	13,073,894	255,096	2.0
1924	455,034	5,312,364	171,559	3.2	1934	1,283,914	15,119,763	232,368	1.5
1925	607,345	7,000,028	214,491	3.1	1935	2,378,668	25,237,532	376,623	1.5
1926	774,728	8,650,780	323,084	3.7					

[4] Further information regarding avian tuberculosis may be obtained in Leaflet 102, Eradicating Tuberculosis from Poultry and Swine.

MEASURES OF PREVENTION

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regulating the movements of cattle, and with that object in view, action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the livestock owner. If each livestock owner takes an active part all through the campaign of tuberculosis eradication, and if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped whenever possible. After diseased animals are found and removed from the premises, a very thorough cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant.[5] Using disinfectants without first doing the necessary and proper cleaning is ineffective, as the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences, can then be sprayed properly with the disinfectant.

All this means much work, but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where livestock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

MARKING ANIMALS FOR IDENTIFICATION

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified. Reactors are branded on the left lower jaw with a letter T about 2 inches high. In addition to the branding, the reacting animals should be properly tagged so that each one may be positively identified, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is placed in the left ear of the animal and contains a serial number as well as the word "Reactor."

Cattle that have passed the tuberculin test are marked by a numbered metal ear tag which is placed in the right ear. It is not often necessary to require special marks on purebred registered cattle, as

[5] Farmers' Bulletin 954, The Disinfection of Stables, gives further information concerning the use of disinfectants for premises.

the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking to show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine to show the origin of those found to be tuberculous on post-mortem examination consists in tattooing a number or mark of identification into the skin of the hog. The method is fully described in Miscellaneous Circular 57, The Tattoo Method of Marking Hogs and Its Use.

Many shipments which contain tuberculous swine are traced back to the originating farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised, efforts can be directed toward eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY

In addition to the various benefits derived from eradicating tuberculosis from cattle, provision for partial compensation for those that are condemned is a further incentive. The laws of 45 States and of the Territories of Alaska and Hawaii provide for a payment for condemned tuberculous cattle, and the Federal Government also bears a share of the expense under certain conditions. The legislation regarding payment of indemnity for tuberculous cattle varies somewhat in different States, and the amount paid by the Federal Government depends somewhat upon the action taken by the State or Territory. Therefore, for detailed and current information on the subject the reader is referred to his State livestock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained from the Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

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FARMERS' BULLETIN No. 1069
Rev. 1937

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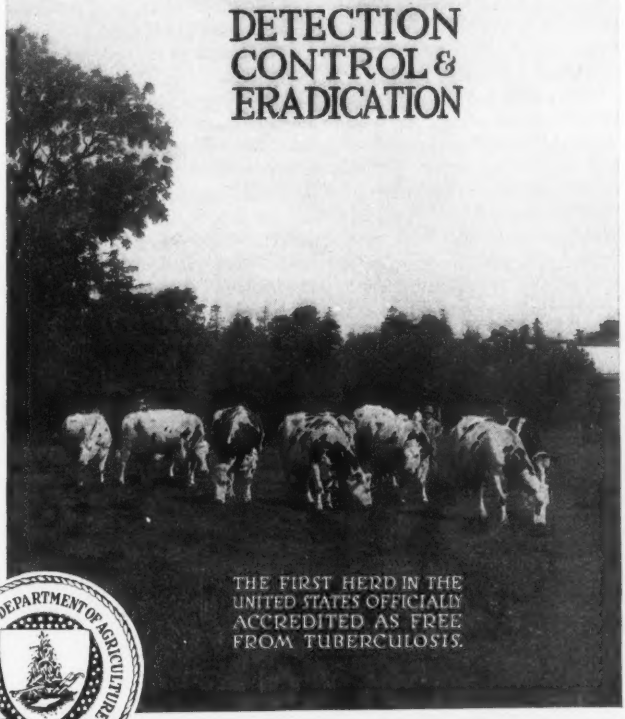
U. S. Department of Agriculture

TUBERCULOSIS IN LIVE STOCK

DETECTION CONTROL & ERADICATION



THE FIRST HERD IN THE UNITED STATES OFFICIALLY ACCREDITED AS FREE FROM TUBERCULOSIS.

HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

1. By the addition of an animal that is affected with the disease. Therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

2. By feeding calves with raw milk or other dairy products from tuberculous cows. This frequently occurs where the owner purchases mixed skim milk from the creamery and feeds it to his calves without first making it safe by boiling or pasteurization.

3. By showing cattle at fairs and exhibitions. Reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

4. By the shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

5. From community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the United States Department of Agriculture, the livestock sanitary officials of the various States, and individual cattle owners.

Washington, D.C.

Issued November 1919
Revised November 1933
Slightly revised 1937

TUBERCULOSIS IN LIVESTOCK

DETECTION, CONTROL, AND ERADICATION[1]

By ALEXANDER E. WIGHT, *Chief, Tuberculosis Eradication Division, Bureau of Animal Industry*

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PRESENT KNOWLEDGE OF TUBERCULOSIS

PROBABLY no disease affecting either the human race or livestock is better known or has been the object of so much study as tuberculosis. Knowledge of the disease is derived from many sources, including the work of eminent scientists who have studied the numerous ways in which it is spread, the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1890 by the eminent scientist, Robert Koch. Thus the test has been known for more than 40 years. The facts regarding it and other information presented in this bulletin are based on long experience and scientific evidence. The methods recommended to be used in the eradication of tuberculosis have been tried and found to be effectual and practicable.

IMPORTANCE OF ERADICATION WORK

The elimination of bovine tuberculosis from a farm and surrounding territory gives a cattle owner numerous advantages, chief among which are increased prices received for surplus breeding cattle and the greater assurance that other livestock on the same farm will not contract tuberculosis. Another important consideration is that of human health. Many cases of tuberculosis among children are traceable to the use of milk from tuberculous cows. If milk is properly pasteurized the living organisms of tuberculosis are destroyed, but raw milk and milk improperly pasteurized may be sources of danger. Many cities and towns have ordinances requiring milk and other dairy products to come from herds that are free from tuberculosis.

[1] This is a revision of former editions by John A. Kiernan, formerly chief of the division, and Dr. Wight. Dr. Kiernan died in 1927.

TUBERCULOSIS A DECEPTIVE DISEASE

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among livestock owners, who would insist upon its immediate eradication; but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals (fig. 1), many people believe that it does comparatively little damage among livestock. Contrary to such opinions, however, the loss from tuberculosis is one of the heaviest taxes imposed upon our livestock industry, amounting, probably, to at least $40,000,000 a year in the United States prior to the time when systematic eradication work was begun.

FIGURE 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. On application of the tuberculin test, 37, or 82 percent of the animals, were found to be tuberculous. The germs of the disease may live for months in manure or litter.

PREVALENCE OF TUBERCULOSIS

The tuberculin test was used to some extent in the United States soon after its discovery, and there was a gradual increase in its use until 1917, when the cooperative campaign was undertaken by the Federal Government and several of the States. During the early part of the campaign there was some tuberculosis in every State and Territory although the degree varied considerably. As the campaign progressed the extent of infection was reduced to 0.5 percent or less of the cattle population in county after county. These counties were designated as modified accredited areas and are considered to be practically free of bovine tuberculosis.

The location of these modified accredited areas is shown in white on the map in figure 2. The vast extent of these areas is conclusive evidence that the early predictions of well-known officials were justified. The late John A. Kiernan, former chief of the Tuberculosis Eradication Division of the Bureau of Animal Industry and coauthor of this bulletin in its original form, firmly believed that with full cooperation of State and local officials bovine tuberculosis could be eradicated from the United States. Similar predictions of State officials have already been realized.

In order to keep officials and other interested persons informed as to the progress of the campaign, the Department issues a monthly summary in mimeographed form showing the number of tests, number of modified accredited counties, and other information for each State. In addition to this the Department issues maps showing the

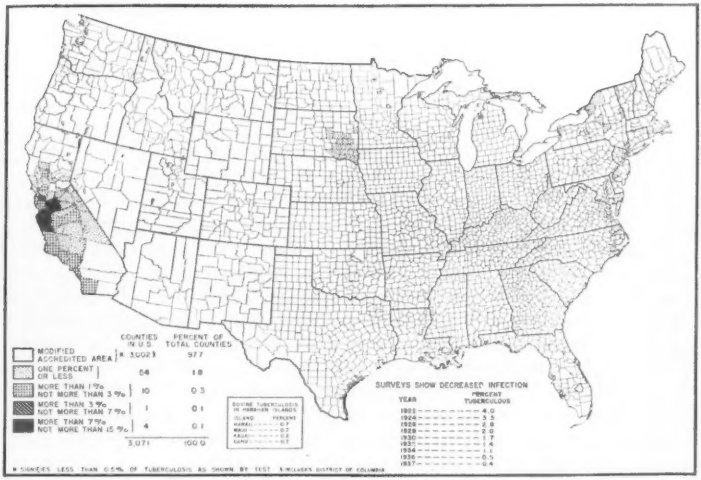

FIGURE 2.—Extent of bovine tuberculosis in the United States, July 1, 1937.

extent of the disease, following Nation-wide surveys which determine the approximate percentage of infection in each county, State, and Territory.

The results of eight biennial surveys, shown below the map at the right, indicate that infection has gradually decreased since eradication work got well under way.

Tuberculosis is known to exist quite extensively among cattle and swine in all the European countries; in fact, no large part of the world is known to be absolutely free from it. There are, however, some restricted regions where its presence is not known or where it exists in but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States tuberculosis among livestock in those regions was unknown. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but livestock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the livestock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

In some localities in the West where dairying has developed extensively it is now known that carload lots of cows purchased in other States have contained 50 percent or more of tuberculous animals. Some herds of beef cattle in the West have become infected with the disease by having placed among them tuberculous purebred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is today. Consequently, in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick. Therefore there is probably less tuberculosis among the herds of the Southern States than in those in any other part of the Nation. This favorable condition should be taken advantage of, for in all probability the livestock industry will reach a high development in that area in future years. It is especially important that the herds of the Southern States be protected by permitting only tuberculosis-free animals to enter.

LOSSES OF MEAT FOOD PRODUCTS

Records kept by the Meat Inspection Division of the Bureau of Animal Industry indicate the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 percent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 percent of these classes of animals slaughtered each year in the United States do not appear in these records. The losses shown in table 1 are therefore considerably less than the total loss throughout the country.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is put aside for further examination. If the disease

TABLE 1.—*Number of cattle, except known reactors, and swine slaughtered and those retained, condemned, and sterilized on account of tuberculosis, at establishments where Federal meat inspection is maintained, 1917–37*

Fiscal year	Cattle			Swine		
	Slaughtered	Retained [1]	Condemned and sterilized	Slaughtered	Retained [1]	Condemned and sterilized
1917	9,276,049	195,488	49,214	40,210,847	3,978,168	168,350
1918	10,912,417	196,917	46,235	35,449,247	3,494,587	148,655
1919	11,212,543	176,250	42,729	44,398,389	4,103,376	165,538
1920	9,666,188	157,016	39,305	38,981,914	4,260,719	159,873
1921	8,137,982	132,068	33,312	37,702,866	4,693,305	161,064
1922	7,795,323	146,945	34,712	39,416,439	5,640,081	166,113
1923	8,934,975	156,738	41,113	48,600,069	7,139,925	202,490
1924	9,049,342	141,595	39,333	54,416,481	8,293,965	225,110
1925	9,595,969	145,012	40,374	48,459,608	7,039,724	192,610
1926	9,817,599	138,506	41,125	40,442,730	5,667,093	145,394
1927	9,810,797	112,924	31,755	42,650,443	5,778,009	132,888
1928	8,837,882	91,856	25,664	48,347,393	5,872,503	125,505
1929	8,120,992	81,276	21,265	47,163,573	5,408,910	104,654
1930	8,119,760	61,192	15,487	46,688,860	5,321,352	96,164
1931	8,061,749	50,725	12,430	44,020,633	5,174,343	88,354
1932	7,793,878	38,446	9,307	45,852,422	5,222,420	83,160
1933	7,554,258	31,971	7,993	45,698,053	4,820,152	76,449
1934	9,476,141	34,509	9,329	45,773,196	5,102,636	77,724
1935	12,563,474	30,569	8,273	34,413,317	3,714,828	52,687
1936	10,215,227	19,076	4,856	28,506,019	2,925,593	31,584
1937	10,853,778	15,816	4,003	36,226,309	3,435,433	33,520

[1] Held for more complete examination to determine final disposal.

is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed, and the remainder is passed. It will be noted that such is the case in most carcasses retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In animals in which the disease is not extensive enough to cause condemnation of the entire carcass the disease is usually in the early stages. Had the animals been allowed to live for possibly only a short time longer the disease would have progressed until all the carcass would have to be considered diseased. In some animals the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and so endanger healthy cattle and swine.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger, State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from those farms.

CAUSE OF TUBERCULOSIS

The cause of tuberculosis is a rod-shaped germ (*Mycobacterium tuberculosis*) discovered by Robert Koch in 1882. This organism can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or livestock

is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself, except as mentioned previously. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures, paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other enclosures which have contained tuberculous animals, before healthy ones are again placed in them.

FIGURE 3.—An insanitary barn. Nearly all the cows kept in it were tuberculous. Premises of this character cannot be kept sanitary.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuberculosis among the stock whenever the germs are present (figs. 3 and 4). Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket that the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued

forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED

The tuberculous cow is the greatest source of danger to healthy cattle. Inasmuch as it cannot be determined just when that animal becomes a "spreader" of the germs unless daily microscopic tests are made of the milk and of the discharges from the body, it is unsafe to keep her with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin-tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming in contact with affected animals than in any other way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

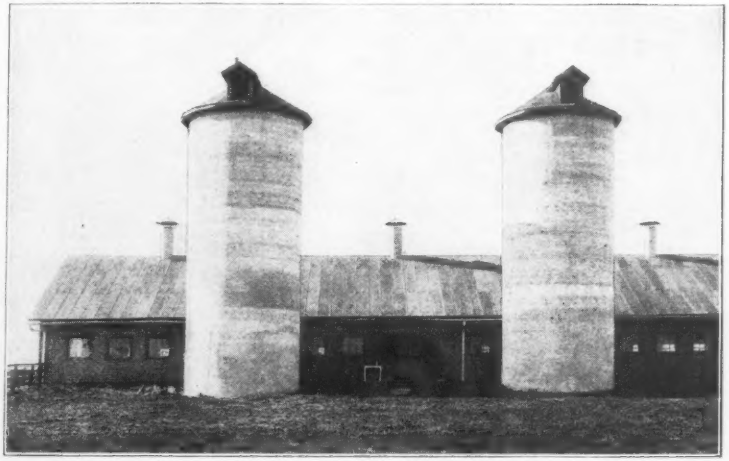

FIGURE 4.—A modern sanitary barn. Note ventilators and liberal window space.

The common water trough, especially in barns, is also the cause, to a very large extent, of spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which the infected milk or the washings from infected milk cans have been dumped may also be a source of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected by drinking raw milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable

attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE BECOME INFECTED

The tuberculous cow is not only a menace to other cattle but is also a source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the distribution of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record also in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are allowed to mingle with them on the same farm, some of the swine are tuberculous. Eradication of tuberculosis from cattle has greatly reduced its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States, is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuberculosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another. Investigations indicate that a large percentage of hogs found to be slightly affected with tuberculosis have contracted the avian type of infection from poultry.[2]

SYMPTOMS OF TUBERCULOSIS

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms (fig. 1). Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening. Cattle affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an ani-

[2] Farmers' Bulletin 1652 describes and gives information on fowl tuberculosis.

mal are affected it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased the animal may develop bloat (fig. 5). Diarrhea is evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

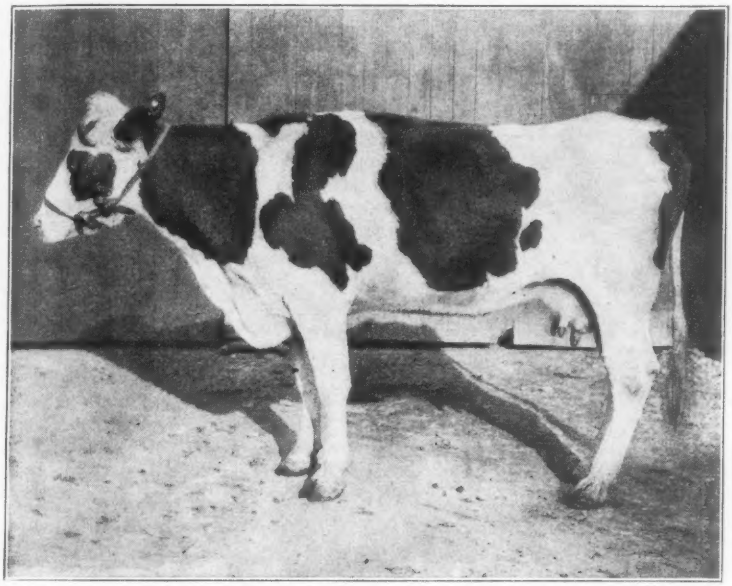

FIGURE 5.—A reacting cow that was constantly bloating. The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating.

METHODS OF DIAGNOSIS

Microscopic examinations of the sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of experience the tuberculin test is now considered to be the most practicable and satisfactory way of diagnosing the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

THE TUBERCULIN TEST

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and used by skillful veterinarians, it is a reliable agent for detecting tuberculosis in animals. Tuberculin contains no tubercle bacilli but is a product of the growth of the germs, properly mixed with a substance on which it has grown and then properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used. Moreover, there is no basis for the claim that the use of the tubercu-

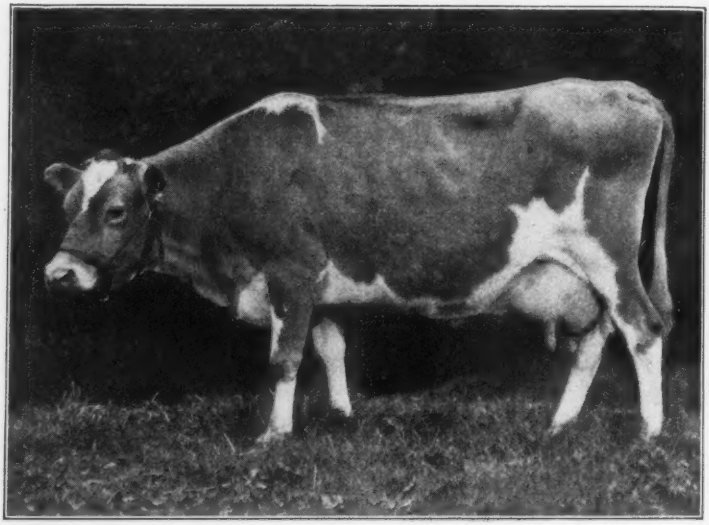

FIGURE 6.—A purebred Guernsey cow that produced 5 sons and 10 daughters, 6 of which made advanced-registry records. She lived until nearly 22 years old, receiving the tuberculin test annually, but showed no reaction or ill effects from the tests. One of her granddaughters made two advanced-registry records and sold at auction for $3,000.

lin test will in any way affect a cow's ability to produce. There are thousands of high producers that are given the tuberculin test annually (fig. 6).

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action. Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to a second application made within a short time; therefore it may be misused by unscrupulous persons.

THE INTRADERMIC TEST (INTO THE SKIN)

The intradermic, also known as the intracutaneous, test for detecting tuberculosis is used extensively. When made by those who have become skilled in its application it is very accurate. In this test the

tuberculin is injected between the layers of the skin, and it is usually applied in the region at the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine, and when so used the tuberculin is applied in the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is usually observed from 72 to 120 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced veterinarian.

THE OPHTHALMIC TEST (OR EYE TEST)

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the other two methods here described. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit.

In all cases the tests, used either alone or in combination, should be applied by capable veterinarians familiar with tuberculin testing.

THE SUBCUTANEOUS TEST (UNDER THE SKIN)

The subcutaneous test is made by injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to take the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are taken at least three times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the veterinarian who applies the test, and a careful observance of any clinical changes is always important in determining the result. It cannot be set forth too strongly that all forms of the tuberculin test should be attempted only by those who are properly qualified to do the work.

POST-MORTEM APPEARANCES

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or

if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs (figs. 7 and 8). The lesions are of various sizes and may contain pus, either soft or hard. Frequently the pus is gritty, especially in swine. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities (fig. 9). Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands are usually affected to some extent, and, when cut into, show diseased areas characteristic of tuberculosis.

FIGURE 7.—Part of a tuberculous udder showing well-developed lesions.

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible even for a person skilled in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals that reacted to the test were not affected with tuberculosis to some extent, even though some of the reactions were very slight.[3]

ERADICATION PROJECTS

Four main projects comprise the general campaign of eradication:

(1) Eradication of tuberculosis from purebred or other individual herds of cattle.
(2) Eradication of tuberculosis from cattle in circumscribed areas.
(3) Eradication of tuberculosis from swine.
(4) Eradication of tuberculosis from poultry.

ACCREDITED-HERD OR HONOR-ROLL PLAN

The accredited-herd or honor-roll plan applies to individual herds. Herds found to be free from tuberculosis on two successive annual tests (fig. 10) are placed on the honor roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of 1 year. This plan has become well known to breeders throughout the United States.

[3] For further information on this subject, see Miscellaneous Publication No. 59, Reliability of the Tuberculin Test.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for purebreds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly tuberculin tested. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

FIGURE 8.—Liver and spleen showing extensive lesions of tuberculosis.

ERADICATION FROM CATTLE IN CIRCUMSCRIBED AREAS

As a general rule, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county may pay (1) part of the expense of exterminating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it may be advisable to clean up the herds within a township or possibly one third or one half of the area. The progress depends

upon the degree of infection found and the cooperation furnished by the owners.

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of about 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin tested; of the total number, 321 cattle, or 18.9 percent, were tuberculous. The reactors were removed from the herds and slaughtered. The infected barns, sheds, and premises were cleaned and disinfected.

Periodically since the inauguration of the campaign all the cattle have been tuberculin tested, with the result that the infection has disappeared. The favorable results obtained here encouraged many livestock owners and State and Federal officials to conduct area work (fig. 11).

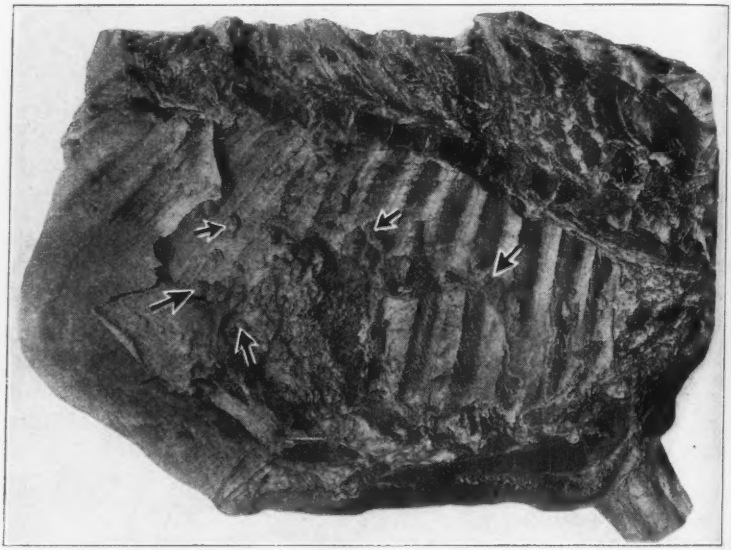

FIGURE 9.—Portion of a beef carcass showing tuberculous nodules on the ribs.

The plan of carrying on eradication under the area plan is practicable and is being conducted in almost all States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The intradermic method should be used, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermic test, the entire herd should be tested again within from 60 to 90 days.

When less than one half of 1 percent of the cattle in a given area, usually a county, are found to be affected with tuberculosis, such area

is declared to be a "modified accredited area." Cattle from such areas may be moved interstate without further tuberculin test, so far as Federal requirements are concerned. The first counties were accredited in July 1923 and 3,040 counties had been accredited up to August 1, 1937. This number includes 30 municipalities in Puerto Rico.

ERADICATION FROM SWINE

With the gradual elimination of tuberculosis from cattle and also from poultry, the prevalence of the disease among swine tends to diminish. It is not necessary to apply the tuberculin test to all the swine herds because it is more economical to send the entire herd, with the exception of valuable breeding animals, to market when fat than to undertake to exterminate the disease in any other way.

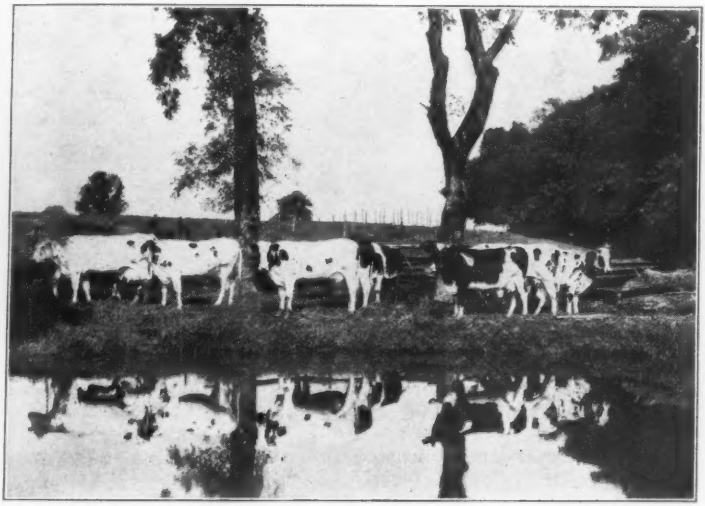

FIGURE 10.—Part of an accredited Holstein-Friesian herd in Virginia. This herd has been free of tuberculosis since 1923.

In case valuable purebred swine are suspected of having tuberculosis they should be tested by the intradermic method. As in the case of cattle, diseased swine should be removed from the farm, and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

ERADICATION FROM POULTRY

Tuberculosis in poultry is caused by a different type of the tubercle bacillus, known as the "avian" type. The disease is very prevalent in the Central and North Central States. In some sections of this area from 50 to 75 percent of the poultry flocks are affected with this disease. Swine are very susceptible to avian tuberculosis, and this fact increases the importance of controlling and eradicating this type of tuberculosis. The disease can be placed under control, and eventually

eradicated, by following approved methods of sanitation and poultry husbandry.[4]

PROGRESS OF ERADICATION

The campaign for the systematic eradication of tuberculosis from livestock has met with increasing favor. Applications for testing are far in excess of the capacity of the available forces and appropriations, and there is always a waiting list of herd owners desiring to have their cattle tested. Table 2 shows the progress made since the early stage of the campaign. Records of the Bureau of Animal

FIGURE 11.—Part of a large herd of Hereford cattle in the range area of Texas. When this herd was tested there were no reactors. The entire county in which this herd ranges is now a modified accredited area.

Industry show that during recent years the testing has progressed at the rate of more than a million cattle a month.

TABLE 2.—*Progress of tuberculosis-eradication work in cooperation with States, 1917–35*

Fiscal year	Herds tested	Cattle tested	Reactors found		Fiscal year	Herds tested	Cattle tested	Reactors found	
			Number	Percent				Number	Percent
1917		20,101	645	3.2	1928	1,048,277	11,281,490	262,113	2.3
1918		134,143	6,544	4.9	1929	1,030,679	11,683,720	206,764	1.8
1919		329,878	13,528	4.1	1930	1,102,423	12,845,871	216,932	1.7
1920	40,348	700,670	28,709	4.1	1931	1,162,414	13,782,273	203,778	1.5
1921	86,687	1,366,358	53,768	3.9	1932	1,139,119	13,443,557	254,785	1.9
1922	195,220	2,384,236	82,569	3.5	1933	1,110,306	13,073,894	255,096	2.0
1923	296,138	3,460,849	113,844	3.3	1934	1,283,914	15,119,763	232,368	1.5
1924	455,034	5,312,364	171,559	3.2	1935	2,378,668	25,237,532	376,623	1.5
1925	607,345	7,000,028	214,491	3.1	1936	1,944,624	22,918,038	165,496	.7
1926	774,728	8,650,780	323,084	3.7	1937	961,109	13,750,308	94,104	.7
1927	871,561	9,700,176	285,361	2.9					

[4] Further information regarding avian tuberculosis may be obtained in Leaflet 102, Eradicating Tuberculosis from Poultry and Swine.

MEASURES OF PREVENTION

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regulating the movements of cattle, and with that object in view, action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the livestock owner. If each livestock owner takes an active part all through the campaign of tuberculosis eradication, and if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped whenever possible. After diseased animals are found and removed from the premises, a very thorough cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant.[5] Using disinfectants without first doing the necessary and proper cleaning is ineffective, as the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences, can then be sprayed properly with the disinfectant.

All this means much work, but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where livestock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

MARKING ANIMALS FOR IDENTIFICATION

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified. Reactors are branded on the left lower jaw with a letter T about 2 inches high. In addition to the branding, the reacting animals should be properly tagged so that each one may be positively identified, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is placed in the left ear of the animal and contains a serial number as well as the word "Reactor."

Cattle that have passed the tuberculin test are marked by a numbered metal ear tag which is placed in the right ear. It is not often necessary to require special marks on purebred registered cattle, as

[5] Farmers' Bulletin 954, The Disinfection of Stables, gives further information concerning the use of disinfectants for premises.

the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking to show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine to show the origin of those found to be tuberculous on post-mortem examination consists in tattooing a number or mark of identification into the skin of the hog. The method is fully described in Miscellaneous Circular 57, The Tattoo Method of Marking Hogs and Its Use.

Many shipments which contain tuberculous swine are traced back to the originating farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised, efforts can be directed toward eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY

In addition to the various benefits derived from eradicating tuberculosis from cattle, provision for partial compensation for those that are condemned is a further incentive. The laws of 45 States and of the Territories of Alaska, Hawaii, and Puerto Rico provide for a payment for condemned tuberculous cattle, and the Federal Government also bears a share of the expense under certain conditions. The legislation regarding payment of indemnity for tuberculous cattle varies somewhat in different States, and the amount paid by the Federal Government depends somewhat upon the action taken by the State or Territory. Therefore, for detailed and current information on the subject the reader is referred to his State livestock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained from the Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

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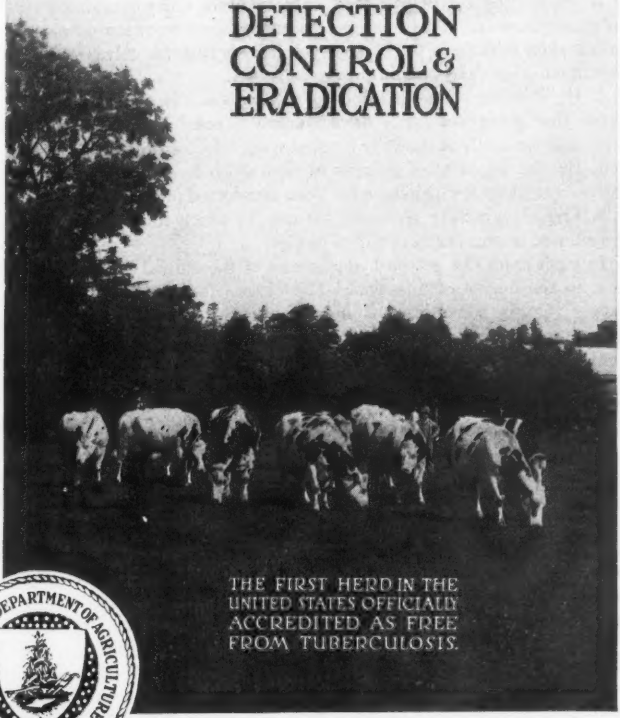
FARMERS' BULLETIN No. 1069
Slightly revised July 1939

TUBERCULOSIS IN LIVE STOCK

DETECTION CONTROL & ERADICATION



THE FIRST HERD IN THE UNITED STATES OFFICIALLY ACCREDITED AS FREE FROM TUBERCULOSIS.

HOW TUBERCULOSIS SPREADS FROM A DISEASED HERD TO A HEALTHY ONE

TUBERCULOSIS may be introduced into a healthy herd by any of the following means:

1. By the addition of an animal that is affected with the disease. Therefore animals should be purchased only from herds known to be free from tuberculosis, or from herds under supervision for the eradication of the disease.

2. By feeding calves with raw milk or other dairy products from tuberculous cows. This frequently occurs where the owner purchases mixed skim milk from the creamery and feeds it to his calves without first making it safe by boiling or pasteurization.

3. By showing cattle at fairs and exhibitions. Reports have indicated that numerous herds have become infected through mingling with infected cattle at shows or by occupying infected premises.

4. By the shipment of animals in cars which have recently carried diseased cattle and which have not been disinfected properly.

5. From community pastures; pastures in which tuberculous cattle are allowed to graze are a source of danger.

In most cases the outward appearance of the animal bears no relation to the degree of infection. The disease frequently develops so slowly that in some cases it may be months or even longer before any symptoms are shown; therefore be on the safe side and have your herd tested.

Tuberculosis eradication is a cooperative work of the Bureau of Animal Industry of the United States Department of Agriculture, the livestock sanitary officials of the various States, and individual cattle owners.

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TUBERCULOSIS IN LIVESTOCK

DETECTION, CONTROL, AND ERADICATION[1]

By ALEXANDER E. WIGHT, *Chief, Tuberculosis Eradication Division, Bureau of Animal Industry*

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PRESENT KNOWLEDGE OF TUBERCULOSIS

PROBABLY no disease affecting either the human race or livestock is better known or has been the object of so much study as tuberculosis. Knowledge of the disease is derived from many sources, including the work of eminent scientists who have studied the numerous ways in which it is spread, the manner by which man and animals contract it, and the effects it produces.

The tuberculin test—the means of detecting tuberculosis—was devised in 1890 by the eminent scientist, Robert Koch. Thus the test has been known for more than 48 years. The facts regarding it and other information presented in this bulletin are based on long experience and scientific evidence. The methods recommended to be used in the eradication of tuberculosis have been tried and found to be effectual and practicable.

IMPORTANCE OF ERADICATION WORK

The elimination of bovine tuberculosis from a farm and surrounding territory gives a cattle owner numerous advantages, chief among which are increased prices received for surplus breeding cattle and the greater assurance that other livestock on the same farm will not contract tuberculosis. Another important consideration is that of human health. Many cases of tuberculosis among children are traceable to the use of milk from tuberculous cows. If milk is properly pasteurized the living organisms of tuberculosis are destroyed, but raw milk and milk improperly pasteurized may be sources of danger. Many cities and towns have ordinances requiring milk and other dairy products to come from herds that are free from tuberculosis.

[1] This is a revision of former editions by John A. Kiernan, formerly Chief of the Division, and Dr. Wight. Dr. Kiernan died in 1927.

TUBERCULOSIS A DECEPTIVE DISEASE

If tuberculosis were similar to foot-and-mouth disease in cattle, swine, and sheep, which causes rather spectacular symptoms, it would arouse immediate alarm among livestock owners, but because it is generally slow in developing and its symptoms commonly are not easily recognized from the general outward appearance of the animals (fig. 1), many people believe that it does comparatively little damage among livestock. Contrary to such opinions, however, the loss from tuberculosis was one of the heaviest taxes imposed upon our livestock industry, amounting, probably, to at least $40,000,000 a year in the United States prior to the time when systematic eradication work was begun.

FIGURE 1.—Portion of a herd of 45 cattle showing no external symptoms of tuberculosis. On application of the tuberculin test, 37, or 82 percent of the animals, were found to be tuberculous. The germs of the disease may live for months in manure or litter.

PREVALENCE OF TUBERCULOSIS

The tuberculin test was used to some extent in the United States soon after its discovery, and there was a gradual increase in its use until 1917, when the cooperative campaign was undertaken by the Federal Government and several of the States. During the early part of the campaign there was some tuberculosis in every State and Territory although the degree varied considerably. As the campaign progressed the extent of infection was reduced to less than 0.5 percent of the cattle population in county after county. These counties were designated as modified accredited areas and are considered to be practically free of bovine tuberculosis (fig. 2).

All States are now (1939) 100 percent modified accredited except California, which still has a few counties not in the modified accredited area. Puerto Rico and the Virgin Islands are in the modified accredited area. The late John A. Kiernan, former chief of the Tuberculosis Eradication Division of the Bureau of Animal Industry and coauthor of this bulletin in its original form, firmly believed that with full cooperation of State and local officials bovine tuberculosis could be eradicated from the United States. Similar predictions of State officials have already been realized.

In order to keep officials and other interested persons informed as to the progress of the campaign, the Department issues a monthly summary in mimeographed form showing the number of tests, number of modified accredited counties, and other information for each State. In addition to this the Department has made biennial Nationwide surveys which determine the approximate percentage of infec-

FIGURE 2.—Part of a large herd of Hereford cattle in the range area of Texas. When this herd was tested there were no reactors. The entire country in which this herd ranges is now a modified accredited area.

tion in each county, State, and Territory. The results of 9 of these biennial surveys, shown below, indicate that infection has gradually decreased since eradication work got well under way.

Year:	Tuberculous cattle *Percent*	Year:	Tuberculous cattle *Percent*
1922	4. 0	1932	1. 4
1924	3. 3	1934	1. 1
1926	2. 8	1936	. 5
1928	2. 0	1938	. 4
1930	1. 7		

Tuberculosis is known to exist quite extensively among cattle and swine in European countries; in fact, no large part of the world is known to be absolutely free from it. There are, however, some restricted regions where its presence is not known or where it exists in but a very moderate degree.

Until cattle from the eastern part of the United States were introduced into the Middle Western, Western, and Southern States tuberculosis among livestock in those regions was unknown. The disease at that time was confined to the herds east of the Allegheny Mountains. It was known then that a considerable percentage of herds in those States were affected, but livestock owners were not inclined to consider tuberculosis as of very great economic importance or dangerous to human health. Therefore very little progress was made in its eradication. As the Central and Western States became settled and cattle were moved westward the disease spread much more rapidly than is generally realized. The spreading in those areas is due, of course, to the fact that the livestock industry occupies a more important part in agriculture than in the Eastern States. Cattle are traded in more extensively and are continually being shipped and trailed from State to State and from farm to farm.

In some localities in the West where dairying has developed extensively it is now known that carload lots of cows purchased in other States have contained 50 percent or more of tuberculous animals. Some herds of beef cattle in the West have become infected with the disease by having placed among them tuberculous purebred bulls and cows that came from diseased herds elsewhere. The importance of controlling tuberculosis and preventing its spread by the interstate movement of diseased animals was not so well recognized during the times of pioneer development as it is today. Consequently, in the absence of regulations and inspection, diseased animals moved from one State to another. The shipment of cattle from Eastern and Northern States to the South, with the exception of dairy herds near the larger cities, did not commence until progress had been made in the eradication of the cattle tick.

LOSSES OF MEAT FOOD PRODUCTS

Records kept by the Meat Inspection Division of the Bureau of Animal Industry indicate the great financial loss caused by tuberculosis every year. They also indicate how widespread tuberculosis in cattle and swine is in the United States, as the establishments in which the diseased animals were slaughtered are in all parts of the country. More than that, only about 65 percent of the cattle and swine, it is estimated, are slaughtered each year in establishments under Federal supervision, so that about 35 percent of these classes of animals slaughtered each year in the United States do not appear in these records. The losses shown in table 1 are therefore considerably less than the total loss for the entire country.

When animals are "retained" by the Federal inspectors on account of tuberculosis it means that some evidence of the disease is discovered and the carcass is put aside for further examination. If the disease is found to be so slight as to render the undiseased portion of the carcass fit for food, the diseased area is removed, and the remainder is passed. It will be noted that such is the case in most carcasses

TABLE 1.—*Number of cattle (except known reactors) and swine slaughtered and those retained, condemned, and sterilized on account of tuberculosis, at establishments where Federal meat inspection is maintained, 1916–38*

Fiscal year	Cattle					Swine				
	Slaughtered	Retained [1]		Condemned and sterilized		Slaughtered	Retained [1]		Condemned and sterilized	
		Number	Percent	Number	Percent		Number	Percent	Number	Percent
	Number					*Number*				
1916	7,387,051	173,754	2.35	39,218	0.53	40,482,799	3,687,817	9.1	169,261	0.42
1917	9,276,049	195,488	2.11	49,214	.53	40,210,847	3,978,168	9.9	168,350	.42
1918	10,912,417	196,917	1.8	46,235	.42	35,449,247	3,494,587	9.9	148,655	.42
1919	11,212,543	176,250	1.57	42,729	.38	44,398,389	4,103,376	9.2	165,538	.37
1920	9,666,188	157,016	1.62	39,305	.41	38,981,914	4,260,719	10.9	159,873	.41
1921	8,137,982	132,068	1.62	33,312	.41	37,702,866	4,693,305	12.4	161,064	.43
1922	7,795,323	146,945	1.87	34,712	.45	39,416,439	5,640,081	14.3	166,113	.42
1923	8,934,975	156,738	1.75	41,113	.46	48,600,069	7,139,925	14.7	202,490	.42
1924	9,049,342	141,595	1.56	39,333	.43	54,416,481	8,293,965	15.2	225,110	.41
1925	9,595,969	145,012	1.51	40,374	.42	48,459,608	7,039,724	14.5	192,610	.4
1926	9,817,599	138,506	1.41	41,125	.42	40,442,730	5,667,093	14	145,394	.36
1927	9,810,797	112,924	1.15	31,755	.32	42,650,443	5,778,009	13.6	132,888	.31
1928	8,837,882	91,856	1.04	25,664	.29	48,347,393	5,872,503	12.1	125,505	.26
1929	8,120,992	81,276	1.0	21,265	.26	47,163,573	5,408,910	11.5	104,654	.22
1930	8,119,760	61,192	.75	15,487	.19	46,688,860	5,321,352	11.4	96,164	.2
1931	8,061,749	50,725	.63	12,430	.15	44,020,633	5,174,343	11.8	88,354	.2
1932	7,793,878	38,446	.5	9,307	.12	45,852,422	5,222,420	11.4	83,160	.18
1933	7,554,258	31,971	.42	7,993	.11	45,698,053	4,820,152	10.5	76,449	.17
1934	9,476,141	34,509	.36	9,329	.10	45,773,196	5,102,636	11.1	77,724	.17
1935	12,563,474	30,569	.24	8,273	.07	34,413,317	3,714,828	10.8	52,687	.15
1936	10,215,227	19,076	.19	4,856	.05	28,506,019	2,925,593	10.3	31,584	.11
1937	10,853,778	15,816	.15	4,003	.04	36,226,309	3,435,433	9.4	33,520	.09
1938	9,934,984	11,668	.1	2,828	.03	32,453,905	2,964,201	9.1	26,088	.08

[1] Held for more complete examination to determine final disposal.

retained, but some loss occurs for the reason that the diseased portions found unfit for food would have a considerable value if healthy.

In animals in which the disease is not extensive enough to cause condemnation of the entire carcass the disease is usually in the early stages. Had the animals been allowed to live for possibly only a short time longer the disease would have progressed until all the carcass would have to be considered diseased. In some animals the lesion of disease has become surrounded by tissue that "locks it up" and prevents it from spreading to other parts of the body. Such a condition, however, is liable to change at any time during the animal's life and allow the disease to enter other parts of the body, and also to be carried out of the body and so endanger healthy cattle and swine.

On the farms from which these animals came, some of the remaining cattle and swine are probably affected with tuberculosis, or will be if allowed to remain there for a sufficient length of time. Knowing this danger, State and Federal officials, when the identity of the animals can be established, trace back as many of the shipments of diseased animals as possible, and through the cooperation of the owner try to exterminate the disease from those farms.

CAUSE OF TUBERCULOSIS

The cause of tuberculosis is a rod-shaped germ (*Mycobacterium tuberculosis*) discovered by Robert Koch in 1882. This organism can be seen only with the aid of a microscope of high magnifying power. The presence of this germ in the bodies of human beings or livestock

is absolutely necessary to produce the disease. The germs of tuberculosis may also be grown artificially in proper material at a temperature of about 98° F.

Outside the bodies of animals the organism is not capable of reproducing itself, except as mentioned previously. When exposed to the direct rays of the sun it dies quickly—a fact to be noted in the disinfection of pastures, paddocks, and barn lots. The organism may live for months, however, when it is protected by dry manure and other materials which form a crust over it and prevent its destruction by the sun's rays. It is of extreme importance, therefore, to clean and disinfect thoroughly all barns, stalls, and other enclosures which have contained tuberculous animals, before healthy ones are again placed in them.

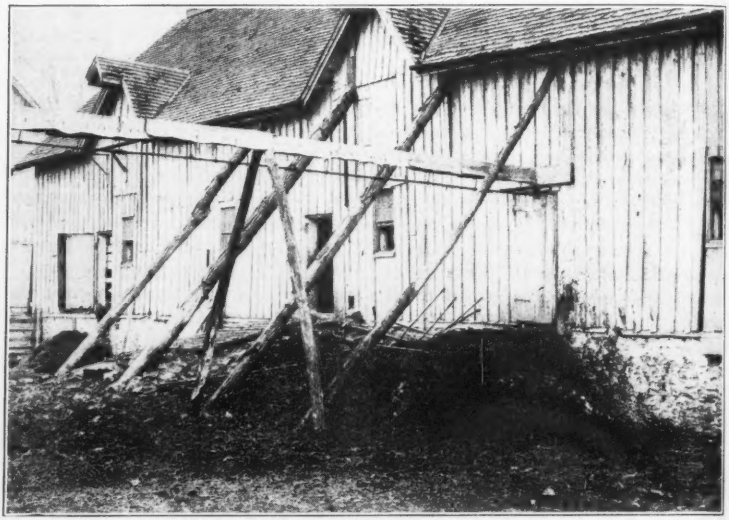

FIGURE 3.—An insanitary barn. Nearly all the cows kept in it were tuberculous. Premises of this character cannot be kept sanitary.

While it is necessary for the germs of tuberculosis to be introduced into the body of the animal before the disease can be produced, there are many conditions or accessory causes which make animals fall victims to tuberculosis.

Animals which are fed on nonnutritious feeds, as well as those that have too little feed, become weakened constitutionally and lose the power to resist the invasion of the organisms. Stabling animals in dark, poorly ventilated, and dirty barns helps to spread tuberculosis among the stock whenever the germs are present (figs. 3 and 4). Introducing a tuberculous animal is almost sure to give the disease to healthy animals in a short time. If the healthy animals drink water from the same trough or bucket that the tuberculous animal uses, and if that animal is coughing up tuberculous sputum, all the animals are in serious danger of infection. Any condition that produces constant strain upon the systems of animals, such as the continued

forced lactation periods of dairy cows, renders them fit subjects for the development of tuberculosis.

HOW CATTLE BECOME INFECTED

The tuberculous cow is the greatest source of danger to healthy cattle. Inasmuch as it cannot be determined just when that animal becomes a "spreader" of the germs unless daily microscopic tests are made of the milk and of the discharges from the body, it is unsafe to keep her with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin-tested and found free from the disease. Unquestionably more healthy cattle acquire tuberculosis by coming in contact with affected animals than in any other way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

FIGURE 4.—A modern sanitary barn. Note ventilators and liberal window space.

The common water trough, especially in barns, is also the cause, to a very large extent, of spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

Water holes and creeks into which the infected milk or the washings from infected milk cans have been dumped may also be a source of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected by drinking raw milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes, but as this method requires considerable

attention to assure proper heating, boiling for a few minutes is considered a better plan.

HOW SWINE BECOME INFECTED

The tuberculous cow is not only a menace to other cattle but is also a source of infection to swine. In some parts of the country, especially where there are whole-milk creameries and skimming stations, feeding mixed skim milk to swine is a common practice. In that way the skim milk from one farm may be fed to hogs on another. Thus it is possible that milk from a few tuberculous cows may set up the infection among swine on many farms.

Milk is a good medium for the distribution of the tubercle bacilli, and swine seem to be extremely susceptible to tuberculosis. Numerous instances are on record also in which the whole milk is separated on the farm, the cream shipped, and the skim milk fed to swine. Consequently one tuberculous animal that is passing the germs in the milk secretions may give the disease to any or all of the animals to which any of the milk is fed. Investigations made by the Bureau of Animal Industry show that in practically every instance where tuberculosis exists among cattle, and swine are allowed to mingle with them on the same farm, some of the swine are tuberculous. Eradication of tuberculosis from cattle has greatly reduced its prevalence among swine.

Another common practice of feeding, especially in the Corn Belt States, is to allow hogs to run with cattle in the feed lots or pastures. If the cattle are tuberculous and the feces contain the germs of tuberculosis, in all probability the swine will contract the disease. Swine may contract tuberculosis also by eating parts of the carcasses of infected cattle, swine, or poultry. Other sources of contamination are infected sputum from human beings, and the feeding of uncooked garbage containing the germs of tuberculosis. Tuberculous swine, like diseased cattle, may also infect one another. Investigations indicate that a large percentage of hogs found to be slightly affected with tuberculosis have contracted the avian type of infection from poultry.[2]

SYMPTOMS OF TUBERCULOSIS

It must be understood that tuberculosis is a disease which often gives no indication of its presence by external symptoms (fig. 1). Yet persons skilled and experienced in dealing with the disease among animals frequently are able to detect certain abnormal conditions which lead them to pronounce the animal as probably affected with tuberculosis. A generally run-down condition, accompanied with a cough, is often considered to be an indication of tuberculosis but is not a conclusive symptom. When tuberculosis is suspected it is always advisable to apply the tuberculin test without delay.

As the disease often involves the lymphatic glands in various parts of the body an examination of such glands as can be felt in the living animal is sometimes helpful in diagnosing the disease. The glands of the throat, udder, and point of the shoulder often present an abnormal condition, such as an enlargement or hardening. Cattle affected with tuberculosis in advanced stages often show a "staring" coat and a generally unthrifty condition. When the throat glands of an ani-

[2] Farmers' Bulletin 1652 describes and gives information on fowl tuberculosis.

mal are affected it often holds its head in an abnormal position in order to relieve the pressure which causes difficult breathing. Increased respiration is often noted when the lungs or lymphatic glands of the thoracic cavity are affected. When some of the glands of that cavity are extensively diseased the animal may develop bloat (fig. 5). Diarrhea is evident in some cases in which infection has extended to the abdominal cavity. The symptoms mentioned, though typical, must not always be expected when animals are tuberculous; animals that are extensively diseased are often in apparently perfect physical condition.

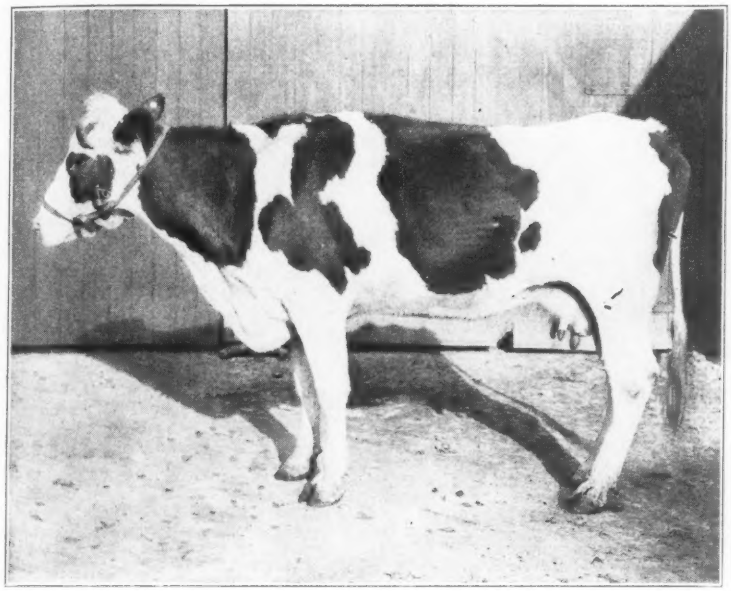

FIGURE 5.—A reacting cow that was constantly bloating. The pressure of greatly enlarged tuberculous glands on the gullet was the cause of the bloating.

METHODS OF DIAGNOSIS

Microscopic examinations of the sputum, milk, and bowel discharges of an animal are sometimes made to determine the presence of tubercle bacilli and to diagnose tuberculosis, but after many years of experience the tuberculin test is now considered to be the most practicable and satisfactory way of diagnosing the disease in the living animal. The inoculation of guinea pigs with emulsions made from milk or discharges from the living animals is sometimes resorted to as a means of diagnosis, but that method of examination is technical and requires special scientific training and equipment. Besides, cases of tuberculosis may be overlooked when laboratory methods are used, because tuberculous animals do not always discharge the tubercle bacilli.

THE TUBERCULIN TEST

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-known standards. Tuberculin is a laboratory product prepared scientifically and, when of standard potency and used by skillful veterinarians, it is a reliable agent for detecting tuberculosis in animals. Tuberculin contains no tubercle bacilli but is a product of the growth of the germs, properly mixed with a substance on which it has grown and then properly diluted and preserved. No harm can result to healthy animals from the proper application of tuberculin even if doses many times greater than the regular ones are used. Moreover, there is no basis for the claim that the use of the tuberculin test will in any way affect a cow's ability to produce. There are thousands of high producers that are given the tuberculin test annually (fig. 6).

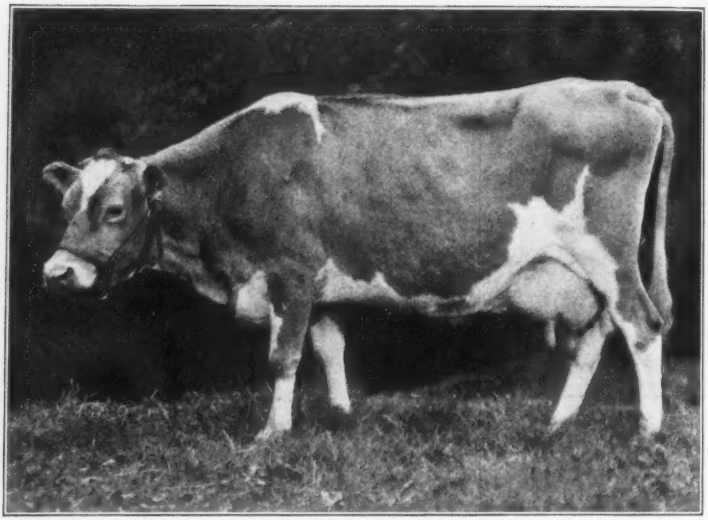

FIGURE 6.—A purebred Guernsey cow that produced 5 sons and 10 daughters, 6 of which made advanced-registry records. She lived until nearly 22 years old, receiving the tuberculin test annually, but showed no reaction or ill effects from the tests. One of her granddaughters made two advanced-registry records and sold at auction for $3,000.

The use of tuberculin by untrained persons is to be discouraged for the reason that in many cases its effect on tuberculous animals is unobserved and not understood by those unfamiliar with its action. Tuberculin, by its immunizing property, can cause tuberculous animals to fail to respond to a second application made within a short time; therefore it may be misused by unscrupulous persons.

THE INTRADERMIC TEST (INTO THE SKIN)

The intradermic, also known as the intracutaneous, test for detecting tuberculosis is used extensively. When made by those who have become skilled in its application it is very accurate. In this test the

tuberculin is injected between the layers of the skin, and it is usually applied in the region at the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine, and when so used the tuberculin is applied in the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is usually observed from 72 to 120 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced veterinarian.

THE OPHTHALMIC TEST (OR EYE TEST)

Still another method, known as the ophthalmic, is used to some extent and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the other two methods here described. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

The ophthalmic test has given best results under farm conditions or in other cases where the eyes are normal. For testing cattle in transit or in the stockyard the test is less dependable, owing to the fact that the eyes may be abnormal as the result of irritation or injury from dust, cinders, or other results of transit.

In all cases the tests, used either alone or in combination, should be applied by capable veterinarians familiar with tuberculin testing.

THE SUBCUTANEOUS TEST (UNDER THE SKIN)

The subcutaneous test is made by injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to take the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are taken at least three times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the veterinarian who applies the test, and a careful observance of any clinical changes is always important in determining the result. It cannot be set forth too strongly that all forms of the tuberculin test should be attempted only by those who are properly qualified to do the work.

POST-MORTEM APPEARANCES

Animals affected with tuberculosis may show the effects of the disease in almost any part of the body. In advanced cases the lesions are easily found, but when the disease is of recent origin or

if a slightly diseased area has been encapsulated or closed up, it is often very difficult to find evidence of the disease. Lesions in advanced cases generally appear as nodules or lumps, which are tubercles formed as a result of the disease. These lumps may be found in great numbers in the lungs and abdominal organs (figs. 7 and 8). The lesions are of various sizes and may contain pus, either soft or hard. Frequently the pus is gritty, especially in swine. Tubercles are often found in various numbers attached to the walls of the thoracic and abdominal cavities (fig. 9). Lesions of the disease also occur in the lungs, liver, and spleen. The lymph glands are usually affected to some extent, and, when cut into, show diseased areas characteristic of tuberculosis.

FIGURE 7.—Part of a tuberculous udder showing well-developed lesions.

Lesions of the disease may be found also in the skin and in or on the bones. In animals only slightly diseased, the lesion may be hidden so that it is impossible even for a person skilled in post-mortem work to find it. A microscopic examination of the lymphatic glands or other tissues often reveals the presence of tubercle bacilli when no lesions can be seen by the naked eye, a condition showing that the disease is just starting. When animals have reacted to the tuberculin test, a very careful post-mortem examination should be made. The action of tuberculin is often discredited when on post-mortem the lesions are not plainly seen, but experience of many years has shown that very few animals that reacted to the test were not affected with tuberculosis to some extent, even though some of the reactions were very slight.[3]

ERADICATION PROJECTS

Four main projects comprise the general campaign of eradication:

(1) Eradication of tuberculosis from purebred or other individual herds of cattle.
(2) Eradication of tuberculosis from cattle in circumscribed areas.
(3) Eradication of tuberculosis from swine.
(4) Eradication of tuberculosis from poultry.

ACCREDITED-HERD OR HONOR-ROLL PLAN

The accredited-herd or honor-roll plan applies to individual herds. Herds found to be free from tuberculosis on two successive annual tests (fig. 10) are placed on the honor roll, and a certificate is given to the owner by the State and the Federal Government. The certificate entitles animals of that herd to be shipped interstate without further tuberculin testing for a period of 1 year. This plan has become well known to breeders throughout the United States.

[3] For further information on this subject, see Miscellaneous Publication No. 59, Reliability of the Tuberculin Test.

The methods of eradicating tuberculosis from grade herds are, of course, the same as for purebreds. No owner can rest assured that his herd is free from tuberculosis unless it has been properly tuberculin tested. Careful physical examination of each animal should be made before or during the application of the test. If animals react to the test they must be separated from the rest of the herd.

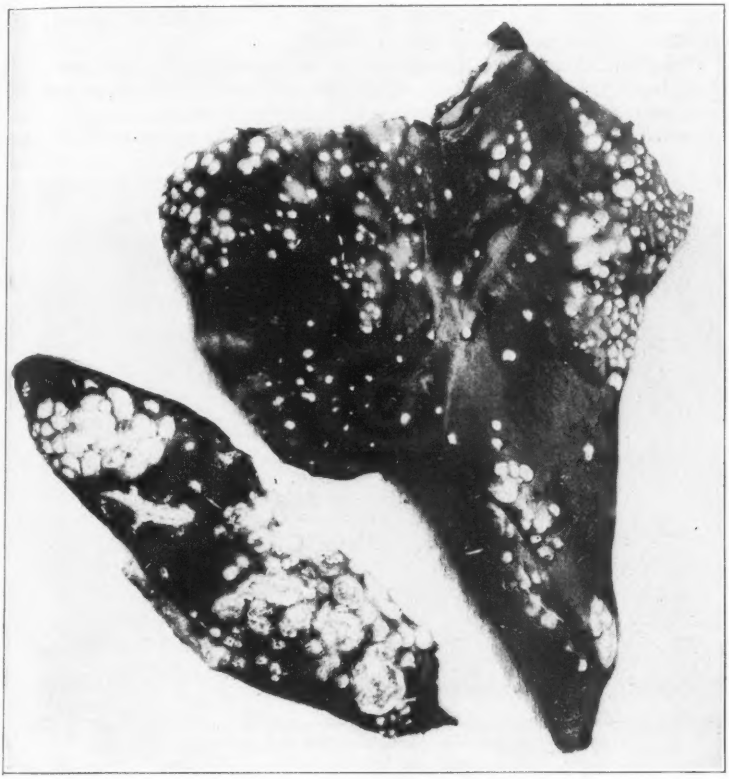

FIGURE 8.—Liver and spleen showing extensive lesions of tuberculosis.

ERADICATION FROM CATTLE IN CIRCUMSCRIBED AREAS

As a general rule, it is best to take up the work by counties, and substantial cooperation should be obtained from the county government. Each county may pay (1) part of the expense of exterminating the disease by employing inspectors to make the tests, (2) part of the indemnities paid for tuberculous animals, and (3) its share of the cost of cleaning and disinfecting infected barns, stables, and sheds. When a large percentage of the herds of a county are diseased, it may be advisable to clean up the herds within a township or possibly one third or one half of the area. The progress depends

upon the degree of infection found and the cooperation furnished by the owners.

In 1910 the Bureau of Animal Industry took up the eradication of tuberculosis from the herds in the District of Columbia, which has an area of about 60 square miles. At that time 1,701 cattle were found. Every animal was tuberculin-tested; of the total number, 321 cattle, or 18.9 percent, were tuberculous. The reactors were removed from the herds and slaughtered. The infected barns, sheds, and premises were cleaned and disinfected.

Periodically since the inauguration of the campaign all the cattle have been tuberculin-tested, with the result that the infection has disappeared. The favorable results obtained here encouraged many livestock owners and State and Federal officials to conduct area work.

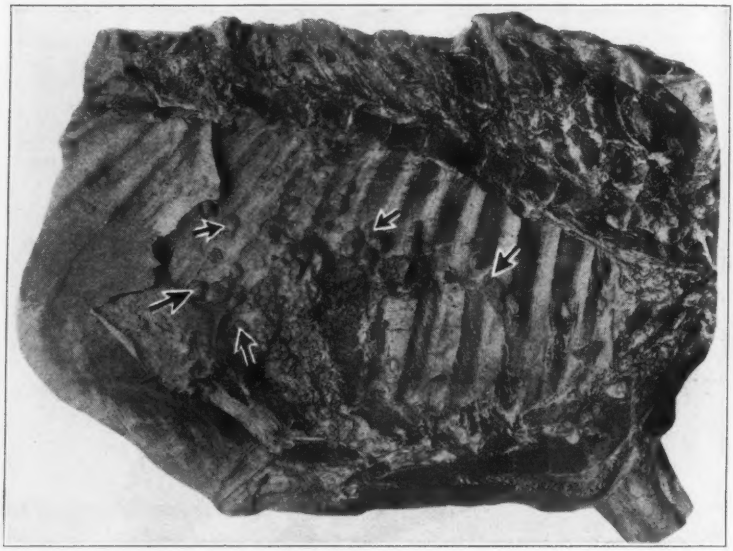

FIGURE 9.—Portion of a beef carcass showing tuberculous nodules on the ribs.

The plan of carrying on eradication under the area plan is practicable and is being conducted in all States.

Before undertaking the work in any area, large or small, the cattle owners should be consulted, and unless they are willing to lend their earnest cooperation and know the sacrifice they may have to make it is inadvisable to start. The better the organization and the more nearly perfect the plans are made, the more efficiently the work should progress.

The intradermic method should be used, as faster progress can be made with it than with the subcutaneous test. If reactors are found in using the intradermic test, the entire herd should be tested again within from 60 to 90 days.

When less than one-half of 1 percent of the cattle in a given area, usually a county, are found to be affected with tuberculosis, such area

is declared to be a modified accredited area. Cattle from such areas may be moved interstate without further tuberculin test, so far as Federal requirements are concerned. The first counties were accredited in July 1923 and 3,142 counties had been accredited up to April 1, 1939. This number includes all municipalities in Puerto Rico and the Virgin Islands.

ERADICATION FROM SWINE

With the gradual elimination of tuberculosis from cattle and also from poultry, the prevalence of the disease among swine tends to diminish. It is not necessary to apply the tuberculin test to all the swine herds because it is more economical to send the entire herd, with the exception of valuable breeding animals, to market when fat than to undertake to exterminate the disease in any other way.

FIGURE 10.—Part of an accredited Holstein-Friesian herd in Virginia. This herd has been free of tuberculosis since 1923.

In case valuable purebred swine are suspected of having tuberculosis they should be tested by the intradermic method. As in the case of cattle, diseased swine should be removed from the farm, and the sheds, farrowing houses, and the lots should be thoroughly cleaned and disinfected.

ERADICATION FROM POULTRY

Tuberculosis in poultry is caused by a different type of the tubercle bacillus, known as the avian type. The disease is very prevalent in the Central and North Central States. In some sections of this area from 50 to 75 percent of the poultry flocks are affected with this disease. Swine are very susceptible to avian tuberculosis, and this fact increases the importance of controlling and eradicating this type of tuberculosis. The disease can be placed under control, and eventually

eradicated, by following approved methods of sanitation and poultry husbandry.[4]

PROGRESS OF ERADICATION

The campaign for the systematic eradication of tuberculosis from livestock met with increasing favor as the work progressed. Table 2 shows the progress made since the early stage of the campaign. Records of the Bureau of Animal Industry indicate that during recent years the testing has progressed at the rate of more than a million cattle a month.

TABLE 2.—*Progress of tuberculosis-eradication work in cooperation with States, 1917–38*

Fiscal year	Herds tested	Cattle tested	Reactors found		Fiscal year	Herds tested	Cattle tested	Reactors found	
			Number	Percent				Number	Percent
1917		20,101	645	3.2	1928	1,048,277	11,281,440	262,113	2.3
1918		134,143	6,544	4.9	1929	1,030,679	11,683,720	206,764	1.8
1919		329,878	13,528	4.1	1930	1,102,423	12,845,871	216,932	1.7
1920	40,348	700,670	28,709	4.1	1931	1,162,414	13,782,273	203,778	1.5
1921	86,687	1,366,358	53,768	3.9	1932	1,139,119	13,443,557	254,785	1.9
1922	195,220	2,384,236	82,569	3.5	1933	1,110,306	13,073,894	255,096	2.0
1923	296,138	3,460,849	113,844	3.3	1934	1,283,914	15,119,763	232,368	1.5
1924	455,034	5,312,364	171,559	3.2	1935	2,378,668	25,237,532	376,623	1.5
1925	607,345	7,000,028	214,491	3.1	1936	1,944,624	22,918,038	165,496	.7
1926	774,728	8,650,780	323,084	3.7	1937	961,109	13,750,308	94,104	.7
1927	871,561	9,700,176	285,361	2.9	1938	1,007,586	14,108,871	89,359	.6

MEASURES OF PREVENTION

Since, after many years of study and experience, no satisfactory cure for tuberculosis among animals has been found, prevention of the disease is extremely important. State and Federal Governments have made vigorous efforts to stop the spread of the disease by regulating the movements of cattle, and with that object in view, action has been taken in some localities to regulate the movement of cattle from one county to another. Regulation of intercounty movement should be encouraged because it brings the matter nearer home to the livestock owner. If each livestock owner takes an active part all through the campaign of tuberculosis eradication, and if he is in favor of measures to prevent the spread of the disease and faithfully abides by those measures, eradication will be accomplished more speedily.

From what has been said already about the dangers of shipping diseased cattle, it is plain that the movement of tuberculous cattle, except for immediate slaughter or to quarantine, must be stopped whenever possible. After diseased animals are found and removed from the premises, a very thorough cleaning and washing of the inside of the barn and other buildings where the animals have been should be made. This must be followed by the proper application of some approved disinfectant.[5] Using disinfectants without first doing the

[4] Further information regarding avian tuberculosis may be obtained in Leaflet 102, Eradicating Tuberculosis from Poultry and Swine.

[5] Farmers' Bulletin 954, The Disinfection of Stables, gives further information concerning the use of disinfectants for premises.

necessary and proper cleaning is ineffective, as the germs of the disease must be exposed. All utensils or anything else that may have become contaminated by use around the diseased animals should likewise be cleaned and disinfected. The manure and refuse must be hauled from barnyards or lots to plowed fields, spread thin, and exposed to the sunlight. The yards and lots, including feed troughs, water troughs, and fences, can then be sprayed properly with the disinfectant.

All this means much work, but it must be done to prevent infection from spreading to the healthy animals. Proper sanitary conditions on premises where livestock are kept is of great importance in keeping the animals healthy and able to resist disease. Sanitation, in its broad sense, includes the admission of abundant sunlight and fresh air properly regulated.

MARKING ANIMALS FOR IDENTIFICATION

It is very important to mark properly all cattle which react to the tuberculin test, so that they may be easily identified. Reactors are branded on the left lower jaw with a letter T about 2 inches high. In addition to the branding, the reacting animals should be properly tagged so that each one may be positively identified, and in that way the results of the post-mortem examination can be connected up with the reporting of the tuberculin tests. The tag is placed in the left ear of the animal and contains a serial number as well as the word "Reactor."

Cattle that have passed the tuberculin test are marked by a numbered metal ear tag which is placed in the right ear. It is not often necessary to require special marks on purebred registered cattle, as the owner usually has a method of identification, and this method of marking can be used in connection with the tuberculin test as a record; but on grade animals it is desirable to use some system of marking to show that the cattle have been tested and found apparently free from tuberculosis.

A system of marking swine to show the origin of those found to be tuberculous on post-morten examination consists in tattooing a number or mark of identification into the skin of the hog. The method is fully described in Miscellaneous Circular 57, The Tattoo Method of Marking Hogs and Its Use.

Many shipments which contain tuberculous swine are traced back to the originating farm by a system of reports kept by the Bureau of Animal Industry. By developing the methods of tracing tuberculous cattle and swine from the abattoir back to the farm where they were raised, efforts can be directed toward eradicating the disease from these herds.

APPRAISEMENT AND INDEMNITY

In addition to the various benefits derived from eradicating tuberculosis from cattle, provision for partial compensation for those that are condemned is a further incentive. The laws of 45 States and of the Territories of Alaska, Hawaii, and Puerto Rico provide for a payment for condemned tuberculous cattle, and the Federal Government also bears a share of the expense under certain conditions. The

legislation regarding payment of indemnity for tuberculous cattle varies somewhat in different States, and the amount paid by the Federal Government depends somewhat upon the action taken by the State or Territory. Therefore, for detailed and current information on the subject the reader is referred to his State livestock sanitary officials or to the inspector in charge representing the Bureau of Animal Industry in cooperative tuberculosis-eradication work. The names and addresses of these officials may be obtained from the Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

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